

FUELS AND LUBRICANTS Testing Apparatus



LAWLER
MANUFACTURING CORPORATION

www.lawlercorp.com

ABOUT LAWLER

Lawler Manufacturing Corporation is celebrating its 61th year of supplying laboratory apparatus for the fuels and lubricants industry.

Lawler Manufacturing Corporation has been a leader in supplying precision controlled high and low temperature laboratory apparatus to the international as well as domestic marketplace. Lawler's specialty is low temperature testing apparatus for the fuels and lubricants industry.

Our customers have come to depend on the quality and reliability of our products. Furthermore, they have come to rely on Lawler's integrity, for we stand behind our products with a full satisfaction guarantee. Many Lawler-made apparatus are still in operation after 25 years of trouble-free service. This commitment to excellence has been the hallmark of Lawler Manufacturing

Corporation for over half a century. And will continue to be into the next century.

Due to the rapid pace of technological innovation it is in clients' interest that we continually improve and upgrade our products.

New products highlighted are a fully automated apparatus for diffuser stone permeability and porosity measuring as per ASTM D892 and D6082, a fully automated apparatus for ASTM D4539 LTFT test, a new heated tube technology for any oxidation and heat stability testing, octane & cetane engine automation and octane reference fuels automated blenders as per ASTM D2699, D2700, D2885, D613.



- *Precise temperature control is dependent on steady voltage supply.*
- *Payment terms are net 10 days for companies that are in good standing.*
- *New accounts need to provide credit and bank references before order acceptance.*
- *International accounts are by wire transfer at time of shipment, or an irrevocable letter of credit (L/C) on a USA bank (with no banking charges for our account). In the case of an L/C there is a \$500.00 freight forwarding and document processing fee. For wire transfer there is a \$35.00 charge.*
- *A 20% cancellation fee will be assessed for orders cancelled 14 days after our acceptance.*
- * *\$100.00 is the minimum order on parts.*
- * *Visa, and Master Card credit cards accepted.*



Please note: *Due to ever increasing spam, our email provider has taken an aggressive posture by blocking all email from those internet service providers (ISP) that allow spammers to abuse their service. As a consequence, some foreign emails to Lawler are never received by Lawler. In this event, address your email to: sales@lawlercorp.com.*

* *Specifications subject to change without notice.*

Bulletin #0501

TABLE of CONTENTS

► VISCOSITY MEASUREMENT

Low Temperature Brookfield Viscosity	4
Low and High Temperature Kinematic Viscosity Baths	8

► FUELS TESTING

Automated Analyzers for Cloud, Pour, Freeze, and Cold Filter Plugging Points	10
Refrigerated Baths for Manual Cloud and Pour Point	12
Refrigerated Baths for Manual Cold Filter Plugging Point	14
Refrigerated Baths for Manual Freeze Point	15
Automated Apparatus for Asphaltine Peptizing of Residual Fuels	16
Data Capture for Manual Testers	17
Automated Apparatus for Low Temperature Flow Test	18
Refrigerated Baths for Manual Low Temperature Flow Test	19
Hydrocarbons by FIA Method	20
Stability of Distillate Fuels	21
Octane & Cetane Engine Automation (Laboratory and On-Line)	22
Automated Blenders for Octane & Cetane Reference Fuels	27

► OIL AND GREASE TESTING

Foaming Tendencies	28
Low Temperature Grease Torque Tester	33
Water Separability	34
API Gravity	35
Stability of Pour Point	36
Grease Dropping Point	37

Refrigerant - Oil Compatibility	37
Automated Cold Crank Simulator	38
Low Temperature Cryostat for Cold Property Analyzers	39
Refrigerated Chillers for CCS and MRV	39
Automated Apparatus for Filterability of Hydraulic Fluids	40
Hydraulic Fluids Hydrolytic Stability	40
Air Release Properties	41
Oil Separability from Grease	41

► OXIDATION, CORROSION AND RUST

Thermal Oxidation Stability Test (TOST)	42
Corrosion & Oxidation of Highly Refined Oils	46
Universal Oxidation Stability Bath	47
Cigre Oxidation Bath	48
Fuels Oxidation Bath	49
Rust Prevention Characteristics	50
Silver, Copper, Lead Corrosion Baths	52
Humidity Cabinet for Rust Protection	55
Asphalt Oxidation for Roofing Materials	56

► MISCELLANEOUS

Foaming of Engine Coolants	56
Rubber Deterioration	57

► INDICES

Index by Method Number	58
Alphabetical Index	60

PROGRAMMABLE LIQUID BATHS for LOW TEMPERATURE BROOKFIELD VISCOSITY

- **Conforms to ASTM D2983-03 Requirements of Note 4 and Annex A2, ISO 9262, and IP267**
- **Superior Data Reproducibility And Repeatability vs. Air Chamber Method**
- **Eliminates Use of Balsa Wood Carriers**
- **Operating Temperature Range from +20° to -55°C**
- **Temperature Stability of $\pm 0.1^\circ\text{C}$**
- **Full Visibility of the Immersed Sample**
- **Single Bath Model and Two Independent Baths Model**

Also for Methods:

ASTM	D2983
ISO	9262
IP	267
Other	CEC-L-18A

The use of programmable liquid baths for ASTM D2983 has been allowed since the first development of the test if the cooling profile meets the specifications of Annex A2 of the method.

The Lawler liquid baths are programmed such that the sample cooling rate equals the cooling rate experienced by a sample when immersed in the constant low temperature air chamber, and as specified by Annex A2 of the method.

The bath can also be programmed to cool at a rate of 1°C per minute from ambient to as low as -55°C as per CEC-L-18A, ISO 9262, and IP 267 for the measurement of European low temperature Brookfield viscosity.

All programmable liquid baths for Brookfield viscosity offered by Lawler are mechanically refrigerated using ozone friendly refrigerants. Operating temperature range is $+20^\circ$ to -55°C with temperature stability of $\pm 0.1^\circ\text{C}$. Windows based PC proprietary software is capable of controlling two baths simultaneously. The twin baths can operate independently at two different temperatures, with independent test starting times and test duration times.

The bath is an unsilvered Dewar jar holding about 3 liters of bath medium. The illuminated jar allows full visibility of the test samples to facilitate the proper positioning of the spindle's bead at the sample's surface.



▲ Model LB-76



▲ Model LB-76-2 Operating Screen

The turntable holds 10 test samples. After the 16 hours conditioning time, the turntable is manually rotated until the proper test cell is under the viscometer. The spindle is connected while the sample is still in the liquid bath. This allows the measurement of viscosity without removing the sample from the temperature controlled environment. Far superior viscosity data repeatability is obtained using this procedure as opposed to the air chamber procedure.

Duplicate samples at -40°C were measured in a Model LB-76 Liquid Programmable Bath. Of the 56 samples, the average variability between the duplicate samples was ±1.13% of mean. This compares very favorably to the method's stated precision of 11.8%. The key factor in this improved precision is the superior temperature control of the sample as its viscosity is being measured.

Model LB-76 Programmable Liquid Bath is a bench top model with a single bath with 10 sample capacity. A Windows based PC is required (not supplied). The bath is supplied with an integral leveling viscometer support rod.

Model LB-76-2 is a bench top model and is identical to Model LB-76 but with two independently controlled baths, each with 10 sample capacity. This allows two simultaneous tests at different temperatures, and independent start and/or stop times.

Model LB-76-2G is identical to Model LB-76-2 but configured as a floor model.

Model LB-76-2T is identical to Model LB-76-2 but is supplied with an integral industrial PC and a touch panel screen.

Model LB-76-2TG is identical to Model LB-76-2T but configured as a floor model.

For those models using an external PC an optional drawer for a laptop PC is available. It fits neatly under the cabinet saving valuable bench space.



▲ Model LB-76-2T

► AVAILABLE MODELS

Model No.	No. of Baths	Sample Capacity	Lowest Temperature	Description	Dimensions inches (cm)	Ship. Weight lbs/cu.ft
LB-76	1	10	-55° C	Bench model	23x24x27 (58x61x69)	300/28
LB-76-2	2	20	-55° C	Bench model	34x27x25 (85x68x63)	440/32
LB-76-2G	2	20	-55° C	Floor model	34x27x60 (85x68x150)	500/40
LB-76-2T	2	20	-55° C	Bench model integral PC touch panel	34x27x25 (85x68x63)	445/32
LB-76-2TG	2	20	-55°C	Floor model Integral PC touch panel	34x27x60 (85x68x150)	500/40

AIR CHAMBERS FOR BROOKFIELD VISCOSITY AT LOW TEMPERATURES

- Conform to ASTM D2983, ISO 9262, IP267
- Temperature stability of $\pm 0.3^{\circ}\text{C}$
- Lowest temperature of -60°C
- Models with dual independent chambers
- Capacity from 6 to 28 samples

Also for Methods:

ASTM	D2983
ISO	9262
IP	267

Four models are available conforming to ASTM D2983 Test Method for Low Temperature Viscosity of Automotive Fluids Measured by Brookfield Viscometer. Each model is equipped with turntable rotating at 4 RPM. Ample storage is provided inside the cold chambers for pre-cooling the insulated cell carriers. A digital, indicating controller with resolution of 0.1°C , maintains set temperature to $\pm 0.3^{\circ}\text{C}$.

Model BV-70 has an 28 cm (11 inch) square, multipane, insulated window with fluorescent light for observation of the interior. The turn table has a capacity for 28 sample. A video chart recorder (option -V) to track possible temperature upsets, and a digital sample temperature display (option -D) are available for Model BV-70.



▲ Model BV-70



▲ Model BV-40-2

Model BV-40 is a smaller, floor space saving, compact unit, with 12 sample capacity. No viewing window is provided, but has a digital sample temperature display.

Model BV-40-2 has two air test chambers. The twin air chambers are independently temperature controlled. The two chambers allow simultaneous conditioning of samples at the same or different temperatures for quicker data collection than with only one apparatus. Each chamber has a turn table with 6 sample capacity.

Model BV-20 is a compact, bench top unit with 6 sample capacity and digital sample temperature display. It is designed for those laboratories with a very light sample load and limited space and budget.

► Available Models:

Model No.	No. of Baths	Sample Capacity	Lowest Temperature	Description	Dimensions inches (cm)	Ship. Weight lbs/cu.ft
BV-20	1	6	-50°C	Bench Model	36x26x19 (91x66x48)	300/28
BV-40	1	12	-50°C	Floor Model	27x34x44 (69x86x112)	440/32
BV-40-2	2	6 + 6	-50°C	Floor Model	34x27x44 (86x69x112)	450/32
BV-70	1	28	-60°C	Floor Model Viewing Window	36x32x42 (91x81x106)	500/53

ACCESSORIES FOR BROOKFIELD VISCOSITY AT LOW TEMPERATURES

Also for Methods:

ASTM	D2983
ISO	9262
IP	267

► BROOKFIELD VISCOSITY

LVDV-II+	Brookfield viscometer with RS232 computer interface
DV Gather+	Data capture software for LVDV-II+ viscometer
ISO-9	Re-calibration and Re-certification of Brookfield Viscometer to ISO9000
LB-VR	Viscometer mounting assembly

► SPINDLES

#4B2	Cylindrical spindle with an insulated shaft to sample temperature upsets during measurement (required for liquid baths such as Model LB-76)
#4	Cylindrical spindle, shaft not insulated (not suitable for liquid baths)

► TEST CELLS

BV-T	Sample test cell, 22-22.5 mm ID, 115 ±5 mm overall length (for air chambers only)
LB-F	Sample test cell, 22-22.5 mm ID, 115 ±5 mm overall length, flat bottomed, sample level mark at 25 ml (for liquid baths)
BV-S	Test cell stopper, 25 mm diameter, 42.5 mm long, with a 9mm centering hole, of Delrin construction (for air chambers only)
LB-Z	Test cell stopper, 25 mm diameter, 28 mm long, with a 9mm centering hole, of Delrin construction (for liquid baths only)

► INSULATED CELL CARRIER

BV-C	Insulated cell carrier, overall dimensions 3 x 3 x 6 inches (75 x 75 x 150 mm) high, top cover, balsa wood construction, dual insulated window for observation of viscosity spindle for proper immersion depth positioning (for air chambers only)
-------------	--

► TEST CELLS COVERS

LB-K	Glass cover for insulating the spindle and upper portion of the test cell while immersed in the sample (liquid baths only)
-------------	--

► VISCOSITY REFERENCE FLUIDS

N14B	Approximately 17,000 cP at -40°C
N27B	Viscosity indicated at -40°, -34°, -29°, -26°, -23°, and -18°C, Approximately 37,000 cP at -40°C
N115B	Viscosity indicated at -29°, -26°, -23°, -18°, -12°, and -7°C, Approximately 12,000 cP at -12°C
N60B	Approximately 150,000 cP at -55°C
N120B	Approximately 150,000 cP at -40°C
N480B	Approximately 150,000 cP at -26°C
N1400B	Approximately 150,000 cP at -12°C

LOW TEMPERATURE KINEMATIC VISCOSITY BATHS

- Conform to ASTM D445, D2532
- Bath Temperature Stability and Uniformity of $\pm 0.05^{\circ}\text{C}$
- Mechanically Refrigerated to -75°C
- Digital Controller with 0.01°C Resolution
- Model with Working Temperature Range of $+150^{\circ}$ to -125°C

Also for Methods:

ASTM	D445, D2532
ISO	3104
IP	71
FTM	791-305
DIN	51 550
NF	T60-100

The kinematic viscosity baths conform to ASTM D445 and D2532 and related test method requirements for viscosity bath temperature stability and uniformity in the temperature range of from $+15^{\circ}$ to -75°C . A digital indicating PID temperature controller with 0.01°C resolution provides stability and uniformity of better than $\pm 0.05^{\circ}\text{C}$ as specified by ASTM D445 (when methyl alcohol or denatured ethyl alcohol are used as bath medium).

The bath jar is an evacuated, unsilvered Dewar flask. The jar is back-lit by a fluorescent light to facilitate reading of the meniscus in the viscometer tubes. A clear plastic viewing window protects the bath jar. Models have either 2 or 4 sample capacity.

Model 77 is configured to accept four 51 mm (2 inch) diameter holders. The 4 viscometer ports can be configured to any viscometer holder configuration by special request. Model 77 temperature range is $+15^{\circ}\text{C}$ to -60°C .

Model 79 is identical to Model 77 but with the operating temperature range of $+15^{\circ}$ to -70°C .

Model 78 is identical to Model 77 but with the operating temperature range of $+15^{\circ}$ to -35°C .

Model 74 has a capacity for 2 viscometers with a temperature range of $+15^{\circ}\text{C}$ to -30°C .

Model 75 has a capacity for 2 viscometers with a temperature range of $+15^{\circ}\text{C}$ to -35°C .

Model 77AV is identical to Model 77 but configured to accept either 1 or 2 Schott automated AVS or TC viscometer holders. It can also be configured to accept one or two automated viscometers by other manufacturers.

Model 81XL when cooled with an external cryostat (or liquid nitrogen) is able to achieve -125°C . The temperature range can be extended to $+150^{\circ}\text{C}$ when used without the cryostat. Temperature stability at above ambient is $\pm 0.02^{\circ}\text{C}$. The unit is similar to Model 77 but without mechanical refrigeration.



▲ Model 77

▶ AVAILABLE MODELS

Model No.	Operating Temperature	Remarks	Dimensions inches (cm)	Ship. Weight lbs/cu.ft
74	$+15^{\circ}$ to -30°C	2 Test Positions	18 x 22 x 34 (45 x 55 x 85)	250/15
75	$+15^{\circ}$ to -35°C	2 Test Positions	18 x 22 x 34 (45 x 55 x 85)	250/15
77	$+15^{\circ}$ to -60°C	4 Test Positions	22 x 24 x 26 (56 x 61 x 66)	300/17
77AV	$+15^{\circ}$ to -60°C	2 Automated Viscometers	22 x 24 x 26 (56 x 61 x 66)	300/17
78	$+15^{\circ}$ to -35°C	4 Test Positions	22 x 24 x 26 (56 x 61 x 66)	250/17
79	$+15^{\circ}$ to -70°C	4 Test Positions	22 x 24 x 26 (56 x 61 x 66)	300/17
81XL	$+150^{\circ}$ to -125°C	4 Test Positions (needs external Cryostat)	22 x 22 x 26 (55 x 66 x 66)	250/17

HIGH TEMPERATURE KINEMATIC VISCOSITY BATHS

- Conform to ASTM D445, D2170, D2171
- Bath Temperature Stability of $\pm 0.02^{\circ}\text{C}$
- Temperature ranges from $+20^{\circ}\text{C}$ to $+250^{\circ}\text{C}$
- Digital Indicating PID Controller

All models conform to the most recent ASTM D445 specifications using a digital indicating PID temperature controller providing bath stability and uniformity of $\pm 0.02^{\circ}\text{C}$. Models with cabinets are made of anodized aluminum frame and panels. A safety viewing window in front of the bath jar provides an insulating air space and protection against breakage. The cabinet improves the temperature stability by reducing the effects of drafts. The jar is illuminated from the bottom by a fluorescent light for easy reading of the meniscus.

Model 86-20 has a 305 mm (12 inch) cubed Pyrex jar enclosed in a safety cabinet. The 7 test positions located near the front of the viewing window allow easy view of the viscometers. Temperature range is 20° to $+150^{\circ}\text{C}$. The digital indicating controller has a display resolution of 0.01°C .

Model 86-16D is an economical, traditional round jar with capacity to accept 7 viscometers. Due to safety concerns of an open jar, the operating temperature is from $+20^{\circ}$ to $+60^{\circ}\text{C}$. Control is provided by a digital indicating controller with 0.1°C resolution.

Model 86-16A is an economical viscosity bath identical to Model 86-16D but using a non-indicating analog controller.

Model 86-17D is the same as Model 86-16D but with a temperature range of $+20^{\circ}\text{C}$ to $+100^{\circ}\text{C}$. A protective Plexiglas tube is supplied for improved temperature stability and improved operator safety.

Also for Methods:

ASTM	D445, D2170, D2171
ISO	3104
IP	71
FTM	791-305
DIN	51 550
NF	T60-100

Model 86-18D is similar to Model 86-16D but has a digital display controller with 0.01°C resolution.

Model 86-25 is a bench space saving compact viscosity bath with 3 test positions in a protective cabinet and with a temperature range of $+20^{\circ}$ to 100°C . A digital indicating controller with a display resolution of 0.01°C provides temperature control of $\pm 0.02^{\circ}\text{C}$. The jar is illuminated for easier meniscus reading.

Model 86-500 is similar to Model 86-20 but with the capacity of operating from $+20^{\circ}$ to $+250^{\circ}\text{C}$. Temperature stability above 150°C is $\pm 0.5^{\circ}\text{C}$. The jar is enclosed in an insulated safety cabinet able to protect the operator from the hot liquid in case of jar breakage. The jar is illuminated for easier meniscus reading.



▲ Model 86-20

▶ AVAILABLE MODELS

Model No.	Operating Temperature	Description	Dimensions inches (cm)	Ship. Weight lbs/cu.ft
86-16A	$+20^{\circ}$ to $+60^{\circ}\text{C}$	Open Jar - Analog Controller	14 x 14 x 18 (35 x 35 x 45)	150/13
86-16D	$+20^{\circ}$ to $+60^{\circ}\text{C}$	Open Jar - 0.1°C Digital Controller	14 x 14 x 18 (35 x 35 x 45)	150/13
86-17D	$+20^{\circ}$ to $+100^{\circ}\text{C}$	Open Jar, Protective Tube Shield 0.1°C Digital Controller	14 x 14 x 18 (35 x 35 x 45)	150/13
86-18D	$+20^{\circ}$ to $+100^{\circ}\text{C}$	Open Jar, Protective Tube Shield 0.01°C Digital Controller	14 x 14 x 18 (35 x 35 x 45)	150/13
86-20	$+20^{\circ}$ to $+150^{\circ}\text{C}$	Enclosed Cabinet Square Jar 0.01°C Controller	17 x 17 x 30 (43 x 43 x 75)	190/14
86-25	$+40^{\circ}$ to $+100^{\circ}\text{C}$	Enclosed Cabinet 3 Test Positions 0.01°C Controller	12 x 23 x 13 (30 x 33 x 58)	180/13
86-500	$+20^{\circ}$ to $+250^{\circ}\text{C}$	Enclosed Cabinet Square Jar 0.01°C Controller	26 x 19 x 29 (65 x 48 x 73)	190/15

AUTOMATED ANALYZERS for COLD PROPERTIES WITHOUT THE USE OF A COOLING CRYOSTAT

- Automated Analyzers for:
 - Pour Point
 - Cloud Point
 - Cold Filter Plugging Point
 - Freeze Point
- No Cryostat Required
- No Hazardous Alcohol Required
- Fully Automated
- Self Contained
- PC Controlled

Also for Methods:

ASTM	D97, ASTM D2500, D2386, D6371
ISO	3013, 3015, 3016
IP	15, 309
FTM	791-201, 1411
DIN	51 597, 51 421
NF	T60-105, M07-048

Many models are available using direct refrigeration technology for cooling automated analyzers for Cloud Point, Pour Point, Cold Filter Plugging Point, and Freeze Point. The metal test jacket is cooled directly by the refrigerant, thus replacing the middle step of first cooling the hazardous alcohol and then pumping the cold alcohol to the metal test jacket.

The advantage of direct refrigeration is rapid cool down to test temperature (within a matter of minutes) as opposed to hours as is the case with the use of a bulky floor model cryostat.

The Automated Cloud Point Analyzer detects the cloud point when the fiber optics shows a reduction of the pulsing green light that reflected from the bottom of the silvered test tube.

The Automated Pour Point Analyzer actually lifts the test sample from the cold jacket and tilts the sample to test for its flow. Flow is detected by a sonic detector reflecting off the sample surface.

The Automated Combination Cloud and Pour Point Analyzer in the same unit. The cloud point analyzer as does the pour point analyzer even lifts from the test bath when detecting for cloud, much in the same manner as done in the manual test. The detection mechanism is the same as in the above described analyzers. If so selected from the software, the cloud point is measured first followed by the measurement for pour point on the same sample without operator intervention.

The Automated Cold Filter Plugging Point Analyzer. The vacuum is applied every degree as the sample cools and its aspiration time recorded and plotted. The result is reported when the aspiration time exceeds 60 seconds. Each test position includes a set of two jars for vacuum control as specified by ASTM D6371 and IP-309.

The Automated Freeze Point Analyzer. The sample cooling is programmed to mimic the cooling profile the sample experiences in the ASTM D2386 manual method. Freezing is detected by a light beam reduction reflected from a mirror as the sample freezes.



▲ Model DR-20L



▲ Model DR-34L

The full operation of the analyzers is controlled by a PC. The proprietary software plots a real time graph of critical parameters as the test sample is cooled. An alarm sounds when the test is complete and the result is displayed. A full year of data is stored and can be retrieved for further spread sheet analysis or downloading to a LIMS.

The software allows the selection of any number of test procedures, such as those duplicating the respective manual ASTM method, pour point at every 1°C, instead of the standard 3°C, start testing at any given temperature, or any method modification desired by the user.

Of particular utility is a fast method for determination of pour point. The results may be significantly accelerated where the jacket temperature begins at room temperature, and is very quickly lowered to below -70°C. Pour point testing is performed every 1° or every 3°C. In many cases for samples with pour points below -40°C may be obtained in less than 1 hour compared with nearly 4 hours using the ASTM D97 procedure. In most cases (depending on sample composition) the results are comparable to those obtained by the slower ASTM D97 procedure.

▶ AVAILABLE MODELS (partial listing):

Model No.	Description
DR-12	1 Cloud Point + 1 Pour Point
DR-14	1 Cloud Point + 1 CFPP
DR-15	1 Cloud Point + 1 Freeze Point
DR-20	1 Pour Point
DR-22	2 Pour Point
DR-24	1 Pour Point + 1 CFPP
DR-25	1 Pour Point + 1 Freeze Point
DR-30	1 Cloud/Pour Points
DR-33	2 Cloud/Pour Points
DR-34	1 Cloud/Pour Points+ 1 CFPP
DR-35	1 Cloud/Pour Points + 1 Freeze Point
DR-40	1 CFPP
DR-44	2 CFPP
DR-45	1 CFPP + 1 Freeze Point
DR-50	1 Freeze Point
DR-55	2 Freeze Point
DR-424*	2 Cloud Points + 2 CFPP
DR-430*	4 Cloud/Pour Points
DR-433*	4 CFPP
DR-442*	3 Pour Point + 1 CFPP
DR-443*	2 Cloud/Pour Points+ 2 CFPP
DR-453*	2 Pour/Cloud Points+ 1 CFPP + 1 Freeze Point

* Available as a floor model only. For other combinations, please inquire.

Two bath temperature options are available:

For -35°C lowest bath temperature use designation -H

For -70°C lowest bath temperature use designation -L.

Overall dimensions for Models DR-20H and DR-40H are 22 x 18 x 33 inches high (55 x 45 x 83cm). Dimensions for all other 1 and 2 position models are 28 x 27 x 33 inches high (70 x 60 x 83 cm.)



▲ Model DR-44L

TEST BATHS for MANUAL TESTING of CLOUD and POUR POINT of PETROLEUM PRODUCTS

- Conform to ASTM D97 and ASTM D2500
- Wide Range of Available Models
- Digital Indicating PID Temperature Controllers for Each Bath

A wide range of models is available (see facing page) with working temperature ranges from +48° to -69°C. Each multi-bath unit conforms to ASTM D97 Pour Point and ASTM D2500 Cloud Point test methods. Each stainless steel liquid bath has its own digital indicating PID temperature controller providing temperature stability of ±1.5°C. Each bath comes equipped with 4 metal test jackets, 4 cork rings, 4 O-rings, and 4 cork stoppers for the thermometer (test tubes are available separately). All units are mechanically refrigerated using ozone friendly non-CFC and non-HCFC refrigerants.

Model 334 is the most popular and versatile 3 bath bench model is the “work horse” of the industry. The baths are factory preset at 0°, -18°, and -34°C. Each bath has 4 test sample capacity. The approximate overall dimensions are 25 x 19 x 26 inches high (62 x 48 x 65 cm.)

Model 644 is also a popular caster mounted, floor model with 4 baths factory preset at 0°, -18°, -34°, and -51°C. Each bath is mechanically agitated for improved bath temperature uniformity and control. Each bath has 4 test sample capacity. Due to bath agitation and temperature stability, Model 644 is suitable for CFPP testing as well. The only additional requirement is the exchange of the metal test jackets (CFPP conversion kit is available). Approximate overall dimensions are 37 x 31 x 43 inches high (94 x 78 x 110 cm.)

Model 654 is a caster mounted floor model with 5 baths factory preset at 0°, -18°, -34°, -51°, -69°C. Each bath is mechanically agitated.

Model 549 is a single bath apparatus adjustable from 0° to -69°C. It is an economical choice for those laboratories with samples with extra low temperature pour point samples.

Model DR-2L with two test positions is a portable, unique cloud and pour point bath, not using any liquid as the cooling medium. It has the ability to very rapidly (less than 2 minutes) change the metal cup temperature to the next lower temperature. This allows one bath to perform the pour and cloud point tests without the need to move the test jar to the next lowest bath temperature. Each cup has its own digital temperature controller and their temperature may be set independently. Lowest bath temperature is -69°C. Model DR-2L is also suitable for CFPP testing.

Also for Methods:

ASTM	D97, D2500, D5853, D6422
IP	15, 219
ISO	3015, 3016
FTM	791-201, 3470
DIN	51 597
NF	T60-105



▲ **Model 644**

Model DR-1H is an economical, compact single test position bath with lowest bath temperature of -34°C. Model DR-1H is designed for cloud & pour point as well as CFPP testing. It is an ideal bath for mobile fuel testing laboratories. Overall dimensions are 22 x 18 x 16 inches high (55 x 45 x 40 cm).

Model DR-1XL is a single test position adjustable from 0° to -120°C. It is useful for those laboratories working with synthetic fluids with very low pour points. Pour point down to -90°C may be determined with this model. The bath is directly refrigerated, using no bath fluid as the cooling medium.

Model 620 is a 20 test sample capacity in each of the 3 baths preset at 0°, -18°, -34°C. It is intended for those laboratories with a very high volume of test samples.

Additional models are listed on the facing page.

TEST BATHS for MANUAL TESTING of CLOUD and POUR POINT

► MOST POPULAR MODELS

Model No.	Number of Baths	Bath Temperatures	Samples per Bath
334	3	0°, -18°, -34° C	4
644	4	0°, -18°, -34°, -51° C	4
654	5	0°, -18°, -34°, -51°, -69° C	4

► DRY BATH MODELS

Model No.	Number of Baths	Bath Temperatures	Samples per Bath
DR-1H	1	Adjustable from 0° to -34° C	1
DR-2H	2	Adjustable from 0° to -34° C	1
DR-1L	1	Adjustable from 0° to -69° C	1
DR-2L	2	Adjustable from 0° to -69° C	1
DR-1XL	1	Adjustable from 0° to -120° C	1

► ADDITIONAL MODELS

Model No.	Number of Baths	Bath Temperatures	Samples per Bath
522	2	0°, -18°, or -18°, -34° C	2
544	1	Adjustable from 0° to -34° C	4
549	1	Adjustable from 0° to -69° C	4
589	1	Adjustable from 0° to -69° C	8
620	3	0°, -18°, -34° C	20
624	2	-51°, -69° C	4
628	2	-51°, -69° C	8
634	3	0°, -18°, -34° C	4
638	3	0°, -18°, -34° C	8
644S	4	Each bath adjustable from 0° to -51° C	4
648	4	0°, -18°, -34°, -51° C	8
654	5	0°, -18°, -34°, -51°, -69° C	4
658	5	0°, -18°, -34°, -51°, -69° C	8
664	6	+48°, +25°, 0°, -18°, -34°, -51° C	4
668	6	+48°, +25°, 0°, -18°, -34°, -51° C	8
674	7	+48°, +25°, 0°, -18°, -34°, -51°, -69° C	4
678	7	+48°, +25°, 0°, -18°, -34°, -51°, -69° C	8

TEST BATHS for MANUAL TESTING of COLD FILTER PLUGGING POINT (CFPP)

- Conform to ASTM D6371, IP-309, D97, D2500, and D5853
- Temperature Stability of $\pm 0.5^{\circ}\text{C}$
- Dry Bath not Requiring Liquid Bath Medium
- Lowest Temperature of -35°C or -70°C
- Quickly Achieves Test Bath Temperature
- Digital Control to 0.1°C Resolution

Also for Methods:

ASTM	D6371, D97, D2500, D5853, D6422
ISO	309
IP	3015, 3016
FTM	791-201
DIN	51 597
NF	T60-105

Model CF-2L has two independently controlled test positions fully conforming to the dimensional specifications of ASTM D6371, and IP-309. Each position accepts one CFPP test assembly (or one pour/cloud point test tube). Each bath temperature is controlled by an indicating digital PID controller with 0.1°C resolution. Bath stability is better than $\pm 0.5^{\circ}\text{C}$ specified by the test method. The test cup is cooled by direct refrigeration thus eliminating the need for a liquid bath medium. Model CF-2L also meets the specifications of ASTM D97, D2500, D5853, and D6422 test methods.

The bath achieves test temperature quickly (2 minutes) from ambient. The bath may be also rapidly changed to the next lowest temperature of -51°C (and -69°C) if so required. Each bath temperature may be set independently of the other.

Model CF-2H is identical to Model CF-2L with the exception that the lowest bath temperature is -35°C . This temperature is sufficient to meet the test requirements for the vast majority of commercial fuels.

Model CF-1L is identical to Model CF-2L with the exception of only having one test position.



▲ **Model CF-2L**

Model CF-1H is identical to Model CF-2H with the exception that of only having one test position.

Model CF-633 is a floor model with 3 liquid baths factory preset at -34° , -51° , -69°C . Each bath is mechanically agitated for improved bath temperature uniformity and control. Each bath has 4 test sample capacity conforming to ASTM D97, D2500, D5853, D6371, D6422, and IP309.

▶ AVAILABLE MODELS

Model No.	Test Positions	Lowest Operating Temperature	Dimensions inches (cm)	Ship. Weight lbs/cu.ft
CF-2L	2	-69°C	28 x 27 x 15 (70 x 70 x 38)	220/15
CF-2H	2	-34°C	18 x 22 x 15 (45 x 55 x 38)	180/12
CF-1L	1	-69°C	28 x 27 x 15 (70 x 70 x 38)	220/15
CF-1H	1	-34°C	18 x 22 x 15 (45 x 55 x 38)	180/12
CF-4H	4	-34°C	48 x 22 x 15 (120 x 55 x 38)	225/20
CF-633	4 per bath	Three Baths Preset at -34° , -51° , -69°C	29 x 31 x 43 (74 x 78 x 110)	400/33

FREEZE POINT APPARATUS

- Conform to ASTM D2386 and D1177 Manual Methods
- Mechanically refrigerated
- Replaces the inconvenience of using liquid nitrogen or dry ice
- Full visibility baths for easy sample observation
- Lowest temperature of -75°C

Also for Methods:

ASTM	D2386, D1177
ISO	3013
IP	16
FTM	791-1411
DIN	51 421
NF	M07-048

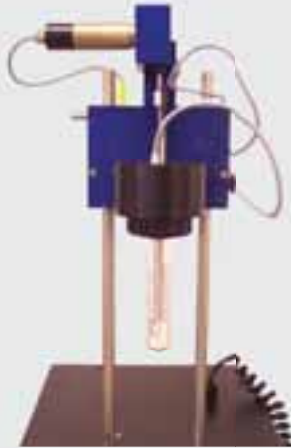
Model 369 is a mechanically refrigerated liquid bath capable of -75°C as the lowest operating temperature. It has a tall, clear Dewar jar accepting two ASTM D2386 or D1177 test assemblies (available separately). The clear Dewar jar allows allowing full visibility of the test sample. The bath is mechanically agitated for improved bath temperature uniformity and stability. Temperature control display is provided by a PID digital indicating controller.

Model 79F has a lowest operating temperature of -75°C. It is a multi-utility bath capable of performing either two manual freeze point tests, or measuring low temperature kinematic viscosity of 4 samples as per ASTM D445.

Model 389 is Model 79F bath equipped with 2 Model MF-10 manual freeze testing assemblies.



▲ **Model 369**



▲ **Model MF-11**

MF-10 is a manual freeze testing assembly mounted on a support rod. The double walled test tube is firmly attached to the assembly to be concentric with the wound wire stirrer. It includes a precision motor moving the wound wire stirrer at 1 to 1.5 cycles per second. The test tube is lowered into a cold bath to begin testing. When the fuel sample freezes the assembly is manually lifted from the cold bath for the operator observe the melting point temperature.

MF-11 is similar to Model MF-10, but with the additional capability to signal the operator to make the observation for freezing when a predetermined sample temperature is reached.

▶ AVAILABLE MODELS

Model No.	Operating Temperature	ASTM Test Method	Sample Capacity	Dimensions inches (cm)	Ship. Weight lbs/cu.ft
369	+15 to -75° C	D2386 and D1177	2	28 x 27 x 37 (71 x 69 x 94)	300/20
389	+15 to -75° C	D2386	2	22 x 22 x 26 (56 x 56 x 66)	310/18
79F	+15 to -75° C	D445 or D2386	4 or 2	22 x 22 x 26 (56 x 56 x 66)	300/17
MF-10		D2386 Manual Test Assembly	1		
MF-11		D2386 Manual Test Assembly with Alarm	1		

AUTOMATED FUELS STABILITY ANALYZER ASPHALTINE PEPTIZING VALVE

- Automated Determination of the Intrinsic Stability of Asphaltenes
- Containing Residues, Heavy Fuel Oils and Crude Oils
- Test Performed at Ambient Temperature
- Rapid Results (15 to 30 minutes)
- Three Simultaneous Measurements
- Reduced Operator Errors
- Operator Time Saving
- Windows XP Based Software
- Quick Payback of Investment

Model 400 Automated Fuels Stability Analyzer applies a procedure for quantifying the intrinsic stability of the asphaltenes in an oil. A sample dissolved in toluene is titrated at room temperature with n-heptane until an optical device detects asphaltine precipitation.

Model 400 is applicable to residual products from thermal and hydrocracking processes, to products typical of ASTM D396 Grades 5L, 5H, and 6, and D2880 Grades 3-GT and 4-GT, and to crude oils. The instrument is limited to products containing a minimum of 0.5% concentration of asphaltenes.

This analyzer quantifies asphaltene stability in terms of state of peptization of the asphaltenes (S-value), intrinsic stability of the oily medium (So) and the solvency requirements of the peptized asphaltenes (Sa). The formalized test method using this instrument is now under active review by the ASTM committee.

The operating principal of Model 400 is based on titration and optical detection of precipitated asphaltenes. Three different mixtures of the sample oil plus aromatic solvent (toluene) are simultaneously and automatically titrated with paraffinic solvent (n-heptane) to cause precipitation of asphaltenes.

An optical probe monitors the formation of flocculated asphaltenes during the titration. The optical probe consists of a system of light emitting and light receiving components. Flocculated asphaltenes alter the detected light intensity.

The start of flocculation is interpreted when the optical probe detects a significant and sustained decrease in rate-of-change of the light intensity.

The results of the three flocculation determinations are used to calculate stability parameters and subsequently the intrinsic stability of the oil from the added n-heptane at the inversion point, the mass of specimen and the volume of toluene, for each determination

Supplied with 3 titration pumps, 3 titration test positions, 3 detection probes, Windows XP based proprietary software, and a PC.



TEMPERATURE DATA ACQUISITION SYSTEM for MANUAL TESTING APPARATUS

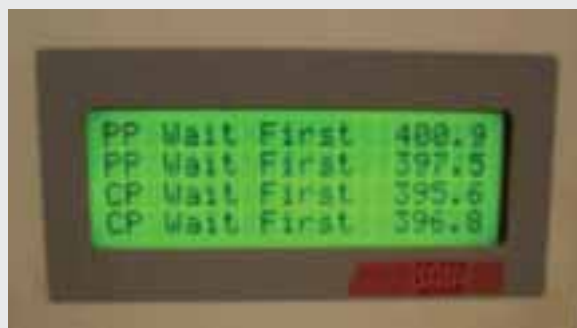
- Acquires, Stores, and Prints Temperature and Results Data
- Assists Operator with the Manual Testing of: Cloud Point, Pour Point, Freeze Point, Flash Point, and Distillation
- Alerts Operator for Next Observation
- Four Simultaneous Tests
- Small and Portable
- Economical Tool Gives New Life to Old Manual Apparatus

Maven Temperature Data Acquisition System is specifically designed to assist the operator in the performance of a number of popular manual tests for petroleum products.

The tests able to be performed with the assistance of Maven are cloud point, pour point, freeze point, flash point, and distillation. It fully conforms to the ASTM D2500, D56, D97, D2386, D92, D93, and D86 test methods, respectively. Any of these tests (mix or match) can be performed simultaneously and independently of each other (up to 4).

Maven accepts up to 4 Pt-100 RTD temperature probes that replace the currently used thermometers. Calibration of these probes is facilitated with the internal firmware.

When prompted by Maven, the operator makes the needed visual observation for any of the test events (such as for cloud, for pour, for flash, for freezing, or for distillation volume). The operator responds by the pressing of a key to indicate the absence of the end point or to indicate the end point itself. A screen displays the test temperature, what action is required, the results, etc.



▲ Maven Screen Close up

Also for Methods:

ASTM	D56, D86, D92, D93, D97, D1310, D2500, D2386, D5853, D6371
ISO	2592, 2719, 3013, 3015, 3016, 3045
IP	15,16,36, 219, 304, 309
FTM	791-201, 1001, 1015, 1103, 1411
DIN	51 597, 51 421
NF	T60-105, M07-002, M07-019, M07-048



▲ Maven

Maven's key benefits are: Improvement of data precision since the automated data acquisition does not rely on the operator's readings or recording of the temperature. Fully traceable recording of data reduces lost data or operator errors. Increased efficiency allowing operator to monitor more tests than now practical. Guides the operator as to the next temperature event such that even new operators can perform the respective tests with less training. Results are printed at the end of the test (printer is an option).

The data output may also be directed to a PC (with an optional software package) allowing the data to be stored in the lab's LIMS or on the hard drive for further statistical analysis.

Maven-D is designed for monitoring and data capture for 4 manual distillations by ASTM D86 test.

Maven and Maven-D are light (15 lbs) and small units (13 x 14 x 7 inches high), portable for easy movement between different test apparatus within a laboratory.

FULLY AUTOMATED APPARATUS for the DETERMINATION of LOW TEMPERATURE FLOW (LTFT)

- Conforms to ASTM D4539 Low Temperature Flow Test
- Fully Automated Operation
- Eliminates the Tedium of the Manual Test
- Capacity for 6 Samples
- User Friendly Window Based Software
- Programmed to Cool at 1° to 6°C/hour
- Liquid Bath Stability of $\pm 0.1^{\circ}\text{C}$
- Operating Range from $+15^{\circ}$ to -55°C

ASTM D4539 Low Temperature Flow Test (LTFT) is generally recognized as a better predictor of diesel fuel filter plugging temperature than the more commonly used ASTM D6371 or IP-309 Cold Filter Plugging Point (CFPP). The test, however, is not widely used since it is long and tedious, requiring operator attention at inconvenient times.

Model 362 is a floor model liquid bath capable of unattended fully automated determination of LTFT of fuels by ASTM D4539. The full process is controlled by an onboard Windows based PC. The proprietary software allows the operator great flexibility to configure the test parameters, etc. A full year of result data is stored in the computer hard disk. The data may be downloaded for future review or statistical analysis or transmitted to a LIMS.

From 1 to 6 samples may be measured at one time. The samples may be the same fuel or multiple different fuels.

The test starts with the operator installing up to 6 sample beakers (plus a dummy sample for temperature measurement) in the liquid bath's rack. After inserting the filter holders and making the connections for the vacuum, the computer program is started.

A semicircular arrangement of sample beakers is used such that filter distance to the receiving beaker of each sample is exactly the same. This is to insure that all dimensions of the apparatus are identical to the specifications of ASTM D4539. A common receiver beaker is used for all 6 samples.

When the sample cools to the pre-selected temperature, the electronically controlled vacuum is applied and the time to filter sample to the receiver is timed. If the time is less than 60 seconds, the cooling continues at $1^{\circ}\text{C}/\text{hour}$ (or any selected rate up to $6^{\circ}\text{C}/\text{hour}$) and the next sample is filtered as before. The process continues automatically until the temperature is reached when it takes the fuel longer than 60 seconds to filter.

For Method:

ASTM D4539



▲ Model 362

The filtered fuel volume level is measured by a non contact laser detector. After the completion of each sample's filtration the receiver beaker is automatically drained into a waste receiver and ready for the next filtration.

Model 289 is identical to Model 362 but lacks the receiver volume measurement, needs a user supplied PC, and comes without the needed filters and glassware.

Model 418 is an economical, compact, bench model for automated LTFT testing. Each of the two test positions has a directly refrigerated dry bath (no bath medium required). It is intended for quality control laboratories that require only pass/fail results.

The dimensions of the caster mounted floor cabinet of Models 362 and 289 are 38 x 26 x 43 inches high (97 x 66 x 109 cm). The shipping weight is approximately 575 Lb. Model 418 dimensions are 28 x 27 x 18 inches high (70 x 60 x 46 cm.).

BATHS for MANUAL LOW TEMPERATURE FLOW TEST (LTFT)

- Meet the Requirements ASTM D4539 Low Temperature Flow Test
- Temperature Range from +15°C to -55°C
- Programmed to Cool at 1.0°C/hour
- Available as Cold Liquid Bath or Cold Air Chamber

For Method:

ASTM D4539

Programmable Cold AIR Chamber

Model 265-10 is a mechanically refrigerated air bath with 10 sample capacity, capable of operating from +15°C to -55°C. The digital programmable controller, displaying both set point and actual temperature, maintains the bath temperature within $\pm 0.3^\circ\text{C}$ of set point. The air chamber temperature uniformity is maintained by a forced air blower.

The insulated air bath has a top opening hood for easy access and minimum of temperature upset when removing samples. The test beakers are conveniently held in a support rack within the cold chamber for most uniform sample cooling.

Programmable Cold LIQUID Bath

Model 265-203L is a mechanically refrigerated liquid bath, operating between +15 to -55°C. It has 12 sample capacity in the mechanically agitated liquid bath. The ramping controller displaying both set point and actual temperature, maintains the bath temperature within $\pm 0.1^\circ\text{C}$ of set point.



▲ Model 265-203L

▶ AVAILABLE MODELS

Model No.	Sample Capacity	Bath Type	Temperature Range	Model Type	Dimensions inches (cm)	Ship. Weight lbs/cu.ft
265-10	10	Air	+15 to -55°C	Floor	28 x 36 x 43 (83 x 94 x 117)	440/43
265-203L	12	Liquid	+25 to -55°C	Floor	28 x 36 x 43 83 x 94 x 117	440/43

▶ ACCESSORIES

Part No.	Description
LTFT-10	Complete filter holder assembly (includes screen)
LTFT-11	Replacement screens (pack of 12)
LTFT-12	300 mL sample beaker (12 pack)
LTFT-13	400 mL receiving beaker, as per test method (1 needed)
LTFT-14	Vacuum pump
LTFT-15	4" Vacuum Gauge 0-25kPa (1% accuracy)
LTFT-16	Automatic electronic vacuum controller
LTFT-17	Precision Vacuum Control Valve
LTFT-18	Table top mounting bracket for gauge and valve
LTFT-19	Socket joint assembly with flex tubing including B/S clamp (1 needed)
LTFT-20	Ball joint with glass tubing and flex tubing (1 needed for each 300 mL sample beaker)
LTFT-21	Storage lid for sample container (1 needed for each 300 mL sample beaker)
LTFT-22	Stopper assembly including rubber stopper with two tubes, hose barbs, one tube with pinch clamp (1 needed)

FLOURESCENT INDICATOR ADSORPTION (FIA METHOD)

- **Conforms to ASTM D1319 Test Method**
- **Two, Four or Six Test Positions**

Also for Methods:

ASTM	D1319
IP	156
FTM	791-3703
NF	M07-024

Model FIA-1319-6 apparatus is used for the determination of saturated, non-aromatic olefins, and aromatics in petroleum fractions that distill below 315°C (600°F). This apparatus conforms to ASTM D1319 and other similar test specifications. Model FIA-1319-6 consists of a wall mounting panel with mounting fixtures for 6 standard adsorption FIA columns, 6 easy to read pressure gauges each with a needle valve, pressure manifold, and a hand held UV lamp.

Model FIA-1319-4 is identical to Model FIA-1319-4 but has 4 test positions.

Model FIA-1319-2 is identical to Model FIA-1319-4 but has 2 test positions.

Overall dimensions are 28 x 6 x 78 inches high (70 x 15 x 195 cm). Shipping weight is approximately 190 lbs.



▲ **Model FIA-1319-4**

► ACCESSORIES

Part No.	Description
FIA-11	Precision bore columns test kit including 2 precision bore columns with spherical joints, clamps, and hose connections
FIA-12	Standard silica gel. Available in A) 50 x 10 gm. packets, B) 100 gm bottle, or C) 1 lb bottle
FIA-13	Dyed silica gel. 100 gm bottle
FIA-14	Cleaning capillary for precision bore columns
FIA-16	Standard column charger/separator with socket joint
FIA-17	Analyzer sections for standard column, 12 pcs.
FIA-20	Clamp for upper spherical joint
FIA-21	Clamp for lower spherical joint
FIA-22	Vibrator for loading the silica gel
FIA-23	Hand-held UV lamp
FIA-24	1 mL Hypodermic syringe with 10 cm needle

HEATED BATHS for HIGH TEMPERATURE STABILITY of DISTILLATE FUELS

- Designed for ASTM D6468 Test Method
- Liquid or Aluminum-Block Baths with 8 Test Positions
- Digital Indicating Temperature Control
- Test Position to Test Position Uniformity of $\pm 0.5^{\circ}\text{C}$
- Over-Temperature Safety Limit Switch
- Temperature Range of 40° to 180°C
- Temperature Stability better than $\pm 0.5^{\circ}\text{C}$

Model L6468-8 is a liquid bath with 8 test positions conforming to ASTM D6468 method. The bath is mechanically agitated and well insulated. The bath temperature range is 40° to 180°C with temperature uniformity and stability better than $\pm 0.5^{\circ}\text{C}$.

Model B6468-8 bath is designed for use with ASTM D6468 test method. It consists of an aluminum block with 8 test positions sized to accept the specified test tubes.

Temperature control is provided by a digital display PID controller providing stability of $\pm 0.5^{\circ}\text{C}$ (or better). The block design is carefully engineered such that position to position uniformity is $\pm 0.5^{\circ}\text{C}$ (or better). In the event of primary controller failure the unit is protected against over heating by a secondary circuit. Useful temperature range is from 40°C up to 180°C .

The block is insulated so the outer cabinet remains cool. A heat resistant composite plastic top with 8 matching holes also provides thermal insulation.



▲ Model L6468-8

For Method:

ASTM D6468



▲ Model B6468-8

The use of an aluminum block dry bath at elevated temperature has the benefit of eliminating the smoke and fire hazard associated with the use of liquid bath mediums. Overall approximate dimensions are 20 x 15 x 12 inch high (51 x 38 x 30 cm).

Model 422 is a compact electronic vacuum controller suitable for sample filtration as per ASTM D6468. It is able to precisely maintain the vacuum at 27 kPa (200 mm Hg). It is adjustable from 1 to 760 mm Hg vacuum and pressure from ambient to 100 psig. The unit is free of mercury (and other hazardous liquids).

Once the Model 422 is powered and a vacuum applied, the set point is quickly achieved and controlled. Vacuum upset are minimized even with large pressure upsets. Steady state vacuum control stability is ± 0.5 mm Hg.

Model PV-577 Digital Reflection Meter as specified by ASTM D6468 method is used for measuring the degree of filter paper staining after oxidation of the distillate fuel. It comes equipped with search unit Y, green filter and polished black glass standard.

AUTOMATION APPARATUS for OCTANE CFR TEST ENGINE

- **FULLY** Conform to ASTM D2699, D2700, D2885
- **NO** Modification to the Engines
- **Quickly Switchable Between Automated and Manual Operation**
- **Models from Data Capture Only to Total Automation**
- **Reduced Operator Training Time**
- **Significant Operator Time Saving**
- **Investment Payback in One Year or Less**
- **Improved Data Precision**
- **Full Documentation for ISO Traceability**
- **Windows XP Based Operating Software**

Upgrading of Waukesha CFR laboratory and on-line octane test engines is now available that fully and in all details conform to ASTM D2699, D2700 and D2885 octane number test methods. The same system is able to perform Bracketing, Falling Level, and Compression Ratio procedures (Procedures A, B, & C) on MON and RON engines.

Unlike other systems, there is NO modification to the CFR engine, and on-the-fly switching from automated to manual operation is done by a simple turn of the fuel selector valve and an electrical switch.

Available are products ranging from economical data capture only, to full hands off automation. Each product is simply upgradable at a later date to the product with a higher degree of automation.

Depending on the degree of automation selected, data is trapped from the knock meter, cylinder height position, and detonation meter. Detailed reports are printed out at end of each test or on command. Historic data is easily retrievable. This data is available for transfer to a LIMS for storage or to a spread sheet for further analysis.

Windows XP based proprietary software does the data capture and data management including all calculations and data storage. This data capture offers full, simplified ISO traceability with full documentation.

All ASTM method tables are automatically corrected for barometric pressure with internal certified instruments. Automated intake air humidity instrument is available as an option.

The software provides step by step check list and instructions that aid even a low skill operator to follow the correct procedure. Operator errors are reduced and data precision is improved.

The system (depending on the degree of automation chosen) provides significant savings of operator's time. In fact, one operator can run 4 CFR engines when each is equipped with the full automation Octatest system. Operator reduction alone can payback the cost of automation in about one year.

Also for Methods:

ASTM	D2699, D2700, D2885
ISO	5164
IP	237
FTM	791-6002, 6005



▲ Installed Model AO-871

Maximum fuel level is automatically determined as per ASTM procedure. This automation improves repeatability and precision of "maximum fuel level" determination.

The software facilitates PRF and TSF blending by doing all the needed calculations. Octane Number is rapidly estimated for bracketing. Integral data base is available for detonation meter calibration for all TSF temperatures. Installation is simple and a minimum of maintenance is required once installed.

Automated engine standardization routine (fit for use) is also part of the package. Automated procedure determines detonation meter settings.


Unlike as in the standard CFR engine, the PRF's, TSF, and test fuels flow through the same jet. This removes one additional variable that improves precision.

The automation reduces operator errors in calculations and data recording. Precision of the octane number is improved compared to the published ASTM method precision (0.3 ON). Users report a precision of 0.1 ON.

The improved precision increases the refinery confidence, allowing it to blend closer to specifications. This reduction in give-away by as much as 70%. A typical refinery can thus see an annual potential saving of \$200,000.00 or more. Pay back on the full Octatest automation is, therefore, less than 1 year.

- Conforms to ASTM D2699 and D2700
- Knock Meter Output Data Capture
- Calculation and Correction of ASTM Tables
- ISO Traceable Print Out Report
- Step by Step Guide to the Operator

Octatest Model OD-201 is the lowest level product capturing data from the knock meter. It comes in a cabinet containing a Windows XP based PC, proprietary software and additional electronics for data capture. It is simply electrically connected to the knock meter output. Model OD-201 may be upgraded at a later date to any of the other octane products.



RESEARCH OCTANE NUMBER DETERMINATION

Octatest O-D-412 Knock Meter Acquisition, Cylinder Height Acquisition D2699
RON Venturi 9/16"

Customer Name : USER
Engine Number : Procedure A Bracketing Equilibrium Fuel Level

Test Dates

Operator : Dick Operator Estimation : 95.75
Sample Identification : Sample 95.7
Start Date : 05.02.2004 Start Time : 06:11:38 Stop Date : 05.02.2004 Stop Time : 06:12:58
Barometric Pressure : 30.01 inHg 1016.0 mbar

Motor Conditions

Intake Air Temperature : 38.00 °C Water : 48.00 g/kg Oil Temperature : 37.00 °C
Mixture Air Temperature : 148.00 °C Oil Pressure : 150.00 kPa
Cylinder Jacket Temp : 100.00 °C Motor Hourly Counter : 125 Hours

Bowls Height

Sample Fuel Bowl Height : 1.000 Inch
PRF 1 Bowl Height : 1.010 Inch
PRF 2 Bowl Height : 1.020 Inch

Reference Values

PRF 1 O.N. Value : 94.00
PRF 2 O.N. Value : 96.00

Readings K.I.	Test 1	Test 2	Average	Criteria
Sample Fuel :	49.02	49.02	49.02	45 K.I. \leftrightarrow average \leftrightarrow 55 K.I. : 49.02
PRF 1 :	73.32	73.32	73.32	Difference \leftrightarrow 0.3 O.N. : 0.00
PRF 2 :	40.82	40.82	40.82	Difference \leftrightarrow 0.3 O.N. : 0.00

Micrometer (Dial)

[mm]		
0.004	Guide Table Value	0015
0.002	Barometric Correction	0002
0.430	Corrected Value	0017
0.430	Actual Value	0009
0.002 \leftrightarrow 0.014	Difference	\pm .0020 -0003

Digital Counter

Minimum ON : 95.20
Maximum ON : 98.30

Detonation Meter Settings

Meter Reading : 4.20
Spread : 5.30
KI Factor : 15.20

Sample 95.7

RESEARCH OCTANE NUMBER

95.50

Date 05.02.2004 Time 06:13:32 Release 2.0.4.30 Page 1

▲ Sample Results Print Out Report

OCTATEST Model OD-412

- Same as Model OD-201 plus
- Data Capture of Cylinder Height

Model OD-412 comes with the same features as Model OD-201 described above, but in addition comes with a device that automatically measures cylinder height. The software captures the knock meter data as well as the cylinder height data. The knock meter reading and cylinder height dial (or digital readout) may also be read as is done with manual operation.

Model OD-412 may be upgraded after the original installation to Model OA-871 or Model OA-871X for full automation.



▲ Cylinder Height Data Acquisition System

OCTATEST Model OA-871

- Conforms to ASTM D2699 & D2700 Procedures A, B, & C
- Total Automation
- Calculation and Correction to ASTM Tables
- Data Capture of Knock Meter & Cylinder Height
- Automated Cylinder Height Control
- Four Fuel Dispenser Bowls
- Automatic Fuel Level Adjustment
- On the Fly Switchable Between Automated and Manual Operation

Octatest Model OA-871 comes with the same features as Model OD-412, but in addition it automatically controls the cylinder height. Safety limit switches are also provided to protect the engine from damage.

Model OA-871 comes with 4 covered bowls of the same volume as the original CFR engine plus an integral glass tube (protected from breakage) showing fuel level. The sample bowl has provision to be cooled by water. The bowls are connected via solenoid valves to a common fuel collector. The system has been designed to avoid fuel cross contamination and to minimize the entrapment of bubbles. Also included is a precision fuel level float that is automatically driven up or down by a high precision stepper motor.

A simple turn of the fuel selector valve and an electric switch returns the control of the CFR engine from automated Model OA-871 to the operator and back again if so desired.

After completion of each test the Octatest software automatically prints a full, detailed report of the engine condition, knock meter reading, digital counter reading, detonation meter settings, the octane number results, etc. The report makes ISO traceability simple, and eliminates the errors of pencil recorded results.



▲ 4 Bowls Fuel Dispenser



▲ Automated Fuel Level Controller

ON-LINE OCTANE CFR ENGINE AUTOMATION

- **Conforms to ASTM D2885 Test Method**
- **No Modification to the CFR Engine**
- **Quick Switching Possible Between Automation and Manual operation**
- **Improved Data Precision**
- **Give Away Reduced by up to 70%**
- **Investment Payback in a Few Months**
- **ISO Traceability is Simplified with Full Documentation**
- **Automated Knock Meter Drift Compensation**
- **Automated Cylinder Height Adjustment**
- **Automated Adjustment of Detonation Meter Parameters**

For Method:

ASTM	D2885
------	-------

Upgrading of Waukesha CFR octane test engines for fully automated on-line operation is now available that fully and in all details conform to ASTM D2885 test method. Unlike other systems, there is NO modification to the CFR engine, and on-the-fly switching from automated to manual operation is done by a simple turn of the fuel selector valve and a single electrical switch.

Depending on degree of automation selected, data is captured from the knock meter, cylinder height position, and detonation meter. The cylinder height position, and detonation meter parameters are automatically adjusted. The software does all data management, calculations, and data storage. This data capture offers full, simplified ISO traceability with full documentation. Detailed reports are printed out at end of each test or on command. Historic data is easily retrievable. This data is available for transfer to a LIMS for storage or to a spread sheet for further analysis.

For stable, crash proof operation a PLC (process logic controller) is used for the controlling system. Proprietary Windows XP based software is used for calibration, and data capture. The level of the falling level bowl is managed by a laser detector for precise control.

All ASTM method tables are automatically corrected for barometric pressure and humidity (optional) with internal sensors.

► AVAILABLE MODELS

ROFA Model 2885-S consists of a cabinet with a PC, and assorted electronics. Windows based proprietary software manages and captures knock meter data. The knock meter drift is automatically compensated.

ROFA Model 2885-SC is the same as ROFA Model 2885-S above but with the additional capability of automated adjustment of cylinder height and the capture of the cylinder height position.

ROFA Model 2885-SCD is the same as ROFA Model 2885-SC above but with the additional capability of automated parameter control of the detonation meter and the capture of the detonation meter data. The improved precision of the octane number allows the refinery to operate with a significantly lower give away, up to 70%.



▲ ROFA Model 2885-SCD

CETANE CFR ENGINE AUTOMATION

- **Conforms to ASTM D613 Test Method**
- **Total Automation**
- **Automated Hand Wheel Position Control**
- **Automated Injection Timing and Fuel Flow Control**
- **Data Capture from Dual Cetane Meter**
- **Calculation and Correction of ASTM Tables**
- **ISO Traceable Print Out Report**
- **Step by Step Guide to the Operator**
- **On-Line Cetane Engine Operation**

Upgrading of laboratory and on-line cetane Waukesha CFR test engines is now available that fully and in all details conforms to ASTM D613 test method. Available are two products for laboratory engines and one for on-line engines.

The software automatically records all data (depending on degree of automation) from dual cetane meter, hand wheel position, injection timing, and ignition delay. Data management and data treatment including all calculations and data storage are done by the software in strict accordance with ASTM D613 method. This data capture offers full, simplified ISO traceability with full documentation. Test results precision is improved. Detailed reports are printed out at end of each test or on command. Historic data is easily retrievable. The data is available for transfer to a LIMS for storage or to a spread sheet for further analysis. All calculations for U & T blends are done by the software.

► AVAILABLE MODELS

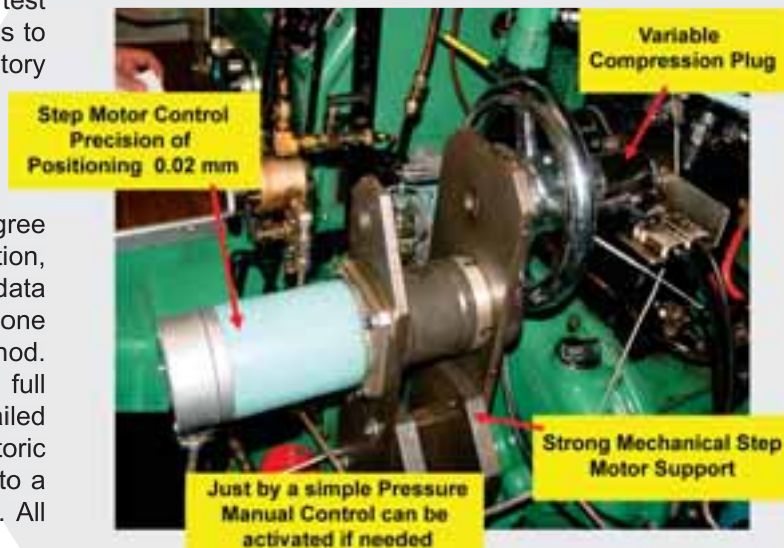
Cetatest Model CD-555X system can now upgrade Waukesha cetane laboratory test engines to capture data from the dual cetane meter and hand wheel position. The Windows XP based proprietary software guides the operator step by step as per ASTM D613 method. These instructions allow even a lesser skilled operator to perform the cetane test as specified by the method.

Cetatest Model CA-745 is the full hands off cetane engine automation system with all the features of the above model, plus automated hand wheel position control, plus injection timing, plus fuel flow control. The hand wheel control is accomplished with a high precision stepper motor mounted to the hand wheel. The positioning precision is 0.02 mm. The hand wheel can still be manually overridden by only a slight finger pressure allowing test continuation in the manual mode.

Cetatest Model CA-970 has all the same features of Model CA-745, above, but is specifically adapted for on-line cetane engine operation.

For Method:

ASTM D613



▲ Driver Motor for the Handwheel



▲ Main Software Operating Screen

Model CA-970 is controlled from the control room, can be started and stopped remotely, and offers automated certification before blending.

AUTOMATED BLENDERS for OCTANE and CETANE REFERENCE FUELS

- Conform to ASTM D2699, D2700, D2885, and D613 Methods
- Rapid Volumetric or Gravimetric Blending
- All Blend Calculation Done by the Software
- Precision of ± 0.02 mL or ± 0.02 gm
- Simple Operation Reduces Operator Errors
- Improved Precision of Octane/Cetane Results
- Fully Automated Preparation of PRF1, PRF2, TSF, U Blends, T Blends
- Motor Driven Laser Detector of Burette Meniscus Volume
- Precision Balance for Gravimetric Measurement

Also for Methods:

ASTM	D2699, D2700, D2885, D613
ISO	5164
IP	237
FTM	791-6002, 6005

Four models of blenders are available for the automated preparation of reference fuels for CFR octane and cetane engines.

One blender is based on the original ASTM methods specified procedure using volume (burettes) as the basis for the blend. Recently, ASTM approved the use of weight (precision balance) as the basis of preparing the blend.

The volumetric blender use a laser meniscus detector driven along the burette length measuring the volume with a precision of 0.02 mL. Three, or four burettes are used, one each for iso-octane, heptane, toluene and 80 O.N. blend. The burettes are automatically filled, either via pressure or gravity feed of the fuel components.

The Windows XP based proprietary software performs all needed blend calculations and corrections for a desired octane or cetane number, and 400 mL of blended reference fuels is delivered. A blend certification report is printed for ISO traceability.

The gravimetric units operate in a similar fashion, but use a precision electronic balance to weight the blend components.

▶ AVAILABLE MODELS

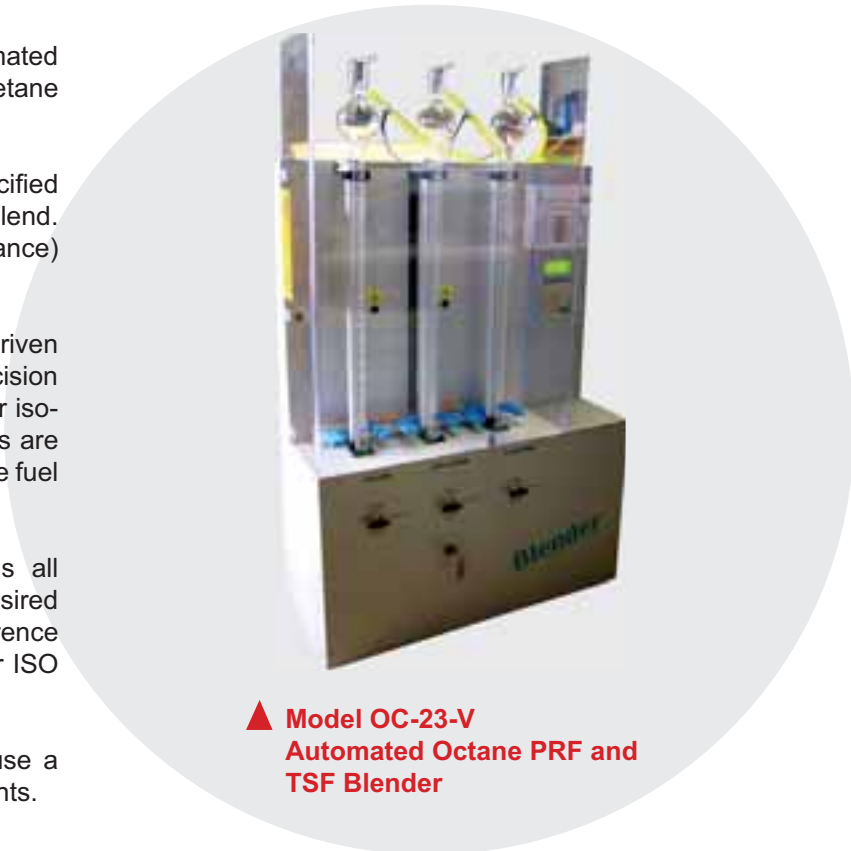
Model OC-23V octane reference fuel blender has 3 ASTM burettes, each burette with a motor driven laser meniscus detector. The burettes may also be used in the traditional manual method. Burettes are available with 4 point volume certification (average of 5 repeats). The operation is controlled by a PLC and receives inputs via a front panel mounted key pad. Model OC-23-V is housed in a space saving cabinet measuring 28 X 20 X 39 inches high (70 X 50 X 100 cm high).

Model OC-34V octane reference fuel blender using laser volumetric meniscus detector. It is similar to Model OC-23-V above but with 4 burettes, one each for toluene, iso-octane, heptane, and 80 ON fuel blend. It is Windows XP PC controlled.

Model OC-55G octane reference fuel blender uses a precision electronic balance, has 4 burettes. The burettes may also be used in the traditional manual method. It is Windows XP PC computer controlled.

Model OC-60G octane reference fuel blender uses a precision electronic balance, has 4 inputs one each for toluene, iso-octane, heptagon, and 80 O.N. fuel but no burettes. It is Windows XP PC computer controlled.

Model CE-82G cetane reference fuel blender has 2 inputs (no burettes) and uses a precision electronic balance to automatically measure the weight of the individual components for U and T blends to the desired cetane number. It is Windows XP PC computer controlled.



▲ **Model OC-23-V
Automated Octane PRF and
TSF Blender**

HEATED AIR BATHS for FOAM TESTING

- Meet the Requirements of ASTM D892 and D6082 for Foaming Characteristics
- Temperature Stability of $\pm 0.5^{\circ}\text{C}$
- Operating Temperatures of 24° , 93.5° , and 150°C
- Digital Indicating PID Temperature Controller
- Rapid Sample Heat Up
- Eliminates Liquid Bath Medium for Improved Safety and Cleanliness
- Two Channel, Automated Mass Flow Control of Air Flow
- Automatic Two Channel Event Sequencer
- Two Channel Exit Air Totalizer

Also for Methods:

ASTM	D892, D6082
IP	146
DIN	51-566
NF	T60-129
FTM	791-3213

Model 323 is a four test position heated AIR bath for measuring the foaming tendencies of lubricating oils in the temperature range of $+24^{\circ}$ to $+150^{\circ}\text{C}$. The use of heated air for heating test samples improves the overall safety by eliminating the use of the potentially unsafe, smoking, dripping, flammable, hot liquid bath medium. Conventional bath fluids darken and require frequent replacement. Use of silicone oils (strong defoamers) is not recommended.

Model 323 uses a digital indicating (0.1°C resolution) PID controller for controlling the air temperature in the chamber, with a stability of better than $\pm 0.5^{\circ}\text{C}$ over the operating range. Novel, sophisticated heating system and control allows the sample to reach test temperature in less than the 60 minutes as specified by the ASTM D6082 method. Sixteen inch long temperature probes are provided for each of the 4 test positions for digital display and precise control of sample temperature.

For improved consistency of results, two digital indicating mass air flow controllers are used for precisely measuring and controlling the amount and rate of air delivered to the air diffuser. The air flow is controlled at either a rate of 94 (for ASTM D892) or 200 ± 5 mL/min. (for ASTM D6082).

An automated, two channel sequencer automatically starts the air flow after the 5 minutes diffuser soak time, after 5 minutes stops the air flow and sounds an alarm, and again sounds an alarm after the 10 minutes settling period.

A touch screen allows the operator selection and full adjustment of all test parameters. All key test parameters are displayed during the test. Also displayed is the time remaining to the next test event requiring operator attention.

A multipane insulated window allows full view of the test cylinder for observation of the foam.



▲ **Model 323**

An assembly with a pair of fans is available as an option to accelerate cooling of the air bath to the next lower test temperature. A chilled water/glycol mixture is required to maintain 24°C (75°F) in the air chamber for ASTM D892 Sequence I and III testing. The chilled mixture is also helpful for rapid cool down of the air chamber for the next test.

Model FM-16 refrigerated chiller suitable for this task is also available.

Model 323-H is identical to Model 323 with the exception that its operating temperature is only 93.5° and 150°C . It is suitable for ASTM D892 Sequence II only, and D6082 test method.

Model 399-4 is similar to Model 323 but is designed to operate at only 24°C . An internal, fluid free refrigeration system maintains 24°C even in a warm laboratory environment.

LIQUID BATHS for FOAM TESTING

- Conforms to ASTM D892 and D6082 Test Methods
- Temperature Stability Better than $\pm 0.5^{\circ}\text{C}$
- Semi Automated Sequencer Model Available

Model 24 dual foam test bath is the traditional arrangement with two glass jars mounted on a supporting base. Each jar accepts two, 1 liter test cylinders for ASTM D892 testing. One bath is typically controlled at 24°C (external cooling required) and the other at 93.5°C . Digital display temperature controllers provide stability of better than $\pm 0.5^{\circ}\text{C}$. Four, float in glass tube flowmeters are provided with micro valves for precision adjustment of air to flow at $94 \text{ mL/min} \pm 5 \text{ mL/min}$. The jar for 93.5°C has a clear plastic protective sleeve to protect the operator from touching the hot surface. A coil is available as an option for the 24°C bath for recirculating chilled water to help maintain the bath temperature. An optional flow through refrigerated chiller is available to maintain the 24°C bath temperature.



▲ Model 24

Model 28 is similar to Model 24 but upgraded for semi automated operation by the addition of Model FM-20 (see page 30). For improved consistency of results, two digital indicating mass air flow controllers are used for precisely measuring and controlling the amount and rate of air delivered to the air diffuser. The air flow is controlled at either a rate of 94 (for ASTM D892) or $200 \pm 5 \text{ mL/min}$ (for ASTM D6082). Sixteen inch long temperature probes are provided for each of the 4 test positions for digital display of sample temperature.

The automated, two channel sequencer automatically starts the air flow after the 5 minutes diffuser soak time, after 5 minutes stops the air flow and sounds an alarm, and again sounds an alarm after the 10 minutes settling period. A touch screen allows the operator selection and full adjustment of all test parameters. All key test parameters are displayed during the test. Also displayed is the time remaining to the next test event requiring operator attention.

Model 12 single position test bath is same as Model 24 but only a single test jar and only two ball in tube flow meters.

Also for Methods:

ASTM	D892, D6082
IP	146
DIN	51-566
NF	T60-129
FTM	791-3213



▲ Model 28

Model 296 high temperature foam test liquid bath is a safer way to perform ASTM D892 as well as D6082 test methods. The glass jar holding the heated liquid bath medium is enclosed in an insulated cabinet with a multipane insulated viewing window. The jar enclosure, in part, protects the operator by limiting the hot bath fluid splash in the event of jar breakage.

The illuminated jar holds two, 1 liter test cylinders. The air flow is measured by two, ball in glass tube flow meters (one for each test position) and adjustable by micro precision valves to a flow rate from 90 to $200 \pm 5 \text{ mL/min}$. The bath temperature control is provided by a digital indicating PID controller with 0.1°C resolution. The temperature stability is better than $\pm 0.5^{\circ}\text{C}$ over the operating range of 40° to 160°C .

A support rack for 4 test tubes is available as an option for convenient storage of the large cylinders.



▲ Test Tube Support Rack

UPGRADING of EXISTING FOAM TESTING APPARATUS

- **Conforms to ASTM D892 and D6082**
- **Automatic, Two Channel Event Sequencer**
- **Two Channel, Automated Mass Flow Control of Air Flow**
- **Improves Precision**
- **Improves Operator Efficiency**

Foam testing apparatus with two jars employed by most laboratories can be simply upgraded to improve the precision of the test and improve operator efficiency. Your current twin jars with their temperature controllers simply fit into the pedestal of Model FM-20. It replaces your flow meters, your stop watch, your operators time, and your poor results. The upgrade has all the advanced electronic features and performance (but no air heating) of Model 323. (See page 28.)

Model FM-20 has two digital indicating mass air flow controllers for precisely measuring and controlling the amount and rate of air delivered to the diffuser. The air flow is controlled at either a rate of 94 (for ASTM D892) or 200 +/-5 mL/min (for ASTM D6082). Unpublished data suggests that mass flow controllers may give improved consistency of results. Model FM-20 is enclosed in a small foot print cabinet: 10 x 15 X 16 inches high (25 x 38 x 41 cm).

Model FM-20 has an automated, two channel sequencer that automatically starts the air flow after the 5 minutes diffuser soak time, after 5 minutes stops the air flow and sounds an alarm, and again sounds an alarm after the 10 minutes settling period.

Also for Methods:

ASTM	D892, D6082
IP	146
DIN	51-566
NF	T60-129
FTM	791-3213

A touch screen panel allows the operator selection and full adjustment of all test parameters including calibration. All key test parameters are displayed during the test. Also displayed is the time remaining to the next test event requiring operator attention. As an option, a two channel totalizer to measure exit air may be incorporate in Model FM-20.



▲ **Model FM-20**

DIGITAL DISPLAY EXIT AIR TOTALIZER

- **Two and One Channel Digital Totalizer of Exit Air**
- **Eliminates the Use of the Wet Test Meter**

To make certain there are no air leaks in the foam testing assembly, ASTM D892 specifies the need to measure the total air exiting the foam cylinder. Lawler offers a simple electronic digital display device that replaces the difficult to use wet test meter. Installation is simple, only requiring a connection to the air outlet tube.

Model FM-21-1 a single channel electronic totalizer digitally displays the total air that is exiting the foam test cylinder. The cabinet size is a small 8 x 11 x 8 inch high (20 x 28 x 20 cm).

Model FM-21-2 is the same as Model FM-21-1 but has two sets of digital display totalizers.



▲ **Model FM 21-2**

AIR DEHUMIDIFIER

- **Meets the Requirements of ASTM D892 and D6082 for Input Air**

Model 26 removes moisture from pressurized house air and is equipped with an electronic sensor measuring the dew

point. ASTM D892 and D6082 test methods specify that air with a dew point of -60°C be used for testing.

DIFFUSER CERTIFICATION APPARATUS for FOAM TESTING OF LUBRICATING OILS

- Fully Automated and Manual Apparatus
- Certify Diffusers Used in ASTM D892 and D6082
- Determine Permeability and Maximum Pore Diameter

The measurement of Foaming Characteristics of Lubricating Oils as per ASTM D892, and ASTM D6082 High Temperature Foam Testing, is dependent upon the quality of the gas diffuser stone used in the test. Certification of the air diffuser involves the determination of critical parameters including PORE DIAMETER and PERMEABILITY for either spherical ceramic (Norton) or cylindrical metal (Mott) diffusers.

ASTM D892 method recommends that the diffusers be tested when new and periodically thereafter, preferably after each use. It is, however, strongly recommended that the retesting of the diffuser be done every 10 tests since plugging occurs after use even with diligent cleaning.

Model FM-19PC Digital Diffuser Certification Apparatus automatically determines both diffuser PORE DIAMETER and PERMEABILITY in accordance with ASTM D892 and D6082. The traditional manometer and wet test meter are replaced by a high precision digital pressure controller and a digital mass flow meter, respectively, both controlled by a PC (PC not included). The pressure ramping is electronically controlled and the first bubble is automatically detected.

The proprietary Windows software manages the testing operation, the required calculations, and all the data. The results are displayed on the screen and can be printed and/or stored on the PC hard drive for ISO 9000 traceability.

Model FM-18PC is similar to Model FM-19PC, above, but requires visual observation for the appearance of the first bubble.

Model FM-18D is a non-automated apparatus, also conforming to ASTM D892 and D6082 for measurement of pore diameter. It consists of a certified (NIST traceable) U-tube manometer capable of reading 1000 mm of water installed on a wall mountable panel.

Also for Methods:

ASTM	D892, D6082, D721, D1881, D3235, D6811, E128
IP	146
DIN	51-566
NF	T60-129
FTM	791-3213

Mounted on the same panel is the apparatus for the determination of permeability which consists of a digital indicating mass flow meter capable of measuring 6000 mL/min. air flow while generating a low back pressure. Model FM-18D eliminates the need for the clumsy and difficult to use wet test meter.



▲ Model FM-19PC

DIFFUSER RE-CERTIFICATION SERVICE

- Used Mott or Norton Diffuser Re-Certification Service to ASTM D892 and D6082
- Quick Turn Around, Economical

Lawler offers a convenient and economical service to certify with NIST traceability your used (cleaned) diffusers to meet the ASTM D892 and D6082 specifications. The service includes engraving the diffuser with a unique number accompanied by a certificate stating the measured pore diameter and permeability.

If the diffuser is outside of the specifications, Lawler offers a 50% credit towards the purchase of a certified replacement diffuser.

AUTOMATED APPARATUS for CLEANING FOAM TESTING CYLINDERS

- Meets The Requirements of ASTM D892 and D6082
- Cleans 4 Foam Test Cylinders Simultaneously
- Each Solvent Flushing Time is Operator Adjustable
- Improved Safety with Minimum Operator Contact with Solvents
- Reduced Risk of Injury by Broken Glass
- Significant Time Savings to the Operator

Model 406 is specifically designed for automated cleaning of up to 4 foam testing cylinders simultaneously. The cleaning process fully conforms to ASTM D892 and D6082 using the specified solvents and drying procedure. The automation of the foam test cylinder cleaning chore releases the operator to more productive activity.

The automated cleaning apparatus enclosed in a front opening cabinet consists of a holder for 4 foam test tubes that are inverted on it (after draining of the test oil). A powerful, air driven pump sends a pulsating spray of solvents in the sequence as specified by the test methods (i.e., heptane, detergent water, distilled water, acetone, and finally drying air). The solvent spray impinges on the bottom of the test tube and then flows along the sides of the tubes for a total cleaning.

To conserve solvents a small amount of clean solvent is introduced into the cylinder and recirculated for an adjustable period of time. This is followed by a clean solvent rinse, and then proceeding to the next cleaning process.

The operation is controlled by an on-board Windows based PC and can be accessed by the operator via a touch panel screen. He/she can select (and store in memory) the times of each step of the sequence. This option gives the operator the flexibility to adjust the flow of each cleaning step to balance time and material use vs. satisfactory cleaning.

The valves controlling the flow of materials are operated by non-sparking, low voltage solenoid valves. All the electronics and all electrical components are in a separate, nitrogen purged compartment. Although precautions have been taken to reduce the fire hazard of this apparatus, Model 406 is not explosion nor fire proof.

The solvents are contained within the test tube and plumbing. This closed system keeps the operator from exposure to the solvents.

Each test position has a manual shutoff valve, thus allowing the cleaning of less than 4 tubes at a time.

The approximate overall dimensions are 31 x 15 x 35 inches high (79 x 38 x 90 cm).

Also for Methods:

ASTM	D892, D6082
IP	146
DIN	51-566
NF	T60-129
FTM	791-3213



▲ Model 406

LOW TEMPERATURE TORQUE of GREASE

- **Conforms to ASTM D1478, D4693**
- **Lowest Operating Temperature of -73°C**
- **Temperature Stability of $\pm 0.3^{\circ}\text{C}$**
- **Models for One or Two Test Positions**

Also for Methods:

ASTM	D1478, D4693
FTM	791-334

The cold air chambers and the included bearing test rigs conform to the requirements of ASTM D1478 Low Temperature Torque of Ball Bearing Greases as well as ASTM D4693 Low Temperature Torque of Grease Lubricated Wheel Bearings test methods.

The top-opening, well insulated cold air chamber is mechanically refrigerated by two hermetically sealed, maintenance-free compressors, arranged in a cascade configuration. Air chamber temperature stability of $\pm 0.3^{\circ}\text{C}$ is maintained by a digital indicating controller. The digital display shows air chamber temperature to 0.1°C resolution. Additional digital displays are provided for measuring test bearing temperature in the case of ASTM D4693.

For both test methods the torque is measured by a strain gauge and is digitally displayed.

Models can be configured with one or two independently operated electric drive systems, operating at 1 rpm, externally mounted on either side of the air chamber. A thermally insulated

drive shaft is used to reduce heat gain by the test bearing. A torque safety limit, stops the electric drive motor if the torque exceeds a preset limit, thus protecting the test rig and the drive shaft from damage (available only with option -V).



▲ Model 64-21

▶ AVAILABLE MODELS

Model No.	Number of Test Positions	Test Method	Dimensions Inches (cm)	Ship Weight lbs/cu.ft
64-10	1	ASTM D1478	35 x 36 x 36 (89 x 91 x 91)	725/43
64-11	2	ASTM D1478	48 x 36 x 36 (122 x 91 x 91)	925/58
64-20	1	ASTM D4693	35 x 36 x 36 (89 x 91 x 91)	725/43
64-21	2	One for each test ASTM D1478 & D4693	48 x 36 x 36 (122 x 91 x 91)	925/58
64-22	2	ASTM D4693	48 x 36 x 36 (122 x 91 x 91)	925/58

▶ ACCESSORIES

Part No.	Description
K	Single conversion kit, from D4693 to D1478 offers additional test flexibility by converting the bearing tester rig from one method to the other.
F	Single conversion kit, from D1478 to D4693 offers additional test flexibility by converting the bearing tester rig from one method to the other.
V	Six channel video display, data capture, and recorder allows easy determination of the peak torque. It visually plots the torque, the air chamber temperature, and temperature of the sample (for D4693 only). Data capture is adjustable as frequently as once every 250 milli-seconds. The data can be either captured on diskette, printed, or simultaneously downloaded to a Windows based PC. It replaces the digital torque and temperature displays.
SC	2 Pen strip chart recorder
SCP	Strip chart paper (10 pack)

WATER-OIL SEPARABILITY (Demulsability) TESTING APPARATUS

- Meets The Requirements of ASTM D1401
- Full Visibility Bath with the Range of 40° to 95°C
- Digital Display Temperature Controller for $\pm 0.1^\circ\text{C}$ Stability
- Capacity for 7 Graduated Test Tubes
- Adjustable Timer for Automated Stirrer Stopping
- Digital Display Stirrer Tachometer

Model 305 meets full requirements of ASTM D1401 Test Method for Water Separability (and related methods). The glass jar heating bath enclosed in a protective cabinet has a range of 40° to 95°C and a stability of $\pm 0.1^\circ\text{C}$. The temperature is digitally displayed with a resolution of 0.1°C.

The bath is protected to prevent over heating in the event of primary controller failure and by a float that will stop the heating in the event of low bath liquid level. The bath cover reduces water loss and has the capacity for 7 test cylinders. The bath is backlit for easier reading of the emulsion separation line.

The adjustable speed stirrer operates at 1500 ± 15 rpm. The stirrer speed is displayed by a digital tachometer. The 7 position turn table rotates under the stirrer motor. The cylinder under test is locked firmly in place exactly centered on the stirrer shaft. The stainless stirrer paddle is 120 mm long, 19 mm wide, and 1.5 mm thick. The stirrer has an adjustable automated timer which stops the agitation and sounds an alarm.

The approximate overall dimensions are 15 x 16 x 30 inches high (38 x 41 x 77 cm). Approximate shipping weight is 135 lbs (61 kg).

Model 305 is available for 115, 208, or 220 volts at 50 or 60 Hz. Please specify power requirements when ordering.

Also for Methods:

ASTM	D1401
ISO	6614
FTM	791-3201
DIN	51 599
NF	T60-125



▲ Model 305

TEST BATHS for SPECIFIC GRAVITY, API GRAVITY of PETROLEUM PRODUCTS

- Conform to ASTM D70, D287, D1298, D2111 Specific and API Gravity
- Operating Temperature Ambient to 150°C
- Temperature Stability of $\pm 0.1^\circ\text{C}$
- Digital Indicating PID Temperature Controller
- Liquid Bath or Heated Tube Bath

Model 177-12 is a 17 inches deep, insulated, stainless steel, agitated liquid bath with capacity to accept 12 specific gravity test tubes (2 inch diameter by 16 inches long). The temperature range is ambient to 150°C. The temperature stability of $\pm 0.1^\circ\text{C}$ is provided by a digital indicating controller with a resolution of 0.1°C.

As safety measure the bath is protected against overheating by secondary controller in the event of primary controller failure.

The bath is equipped with an adjustable water overflow pipe to maintain the correct bath level when the hydrometer cylinders are immersed.

Model 177-6 is similar to Model 177-12 but large enough for only 6 test positions.

Model 177-4D is an open glass jar bath, 18 inches deep able to accept 4 specific gravity test tubes. It has a digital display controller with 0.1°C resolution. Operating temperature range is ambient to 100°C. If operating above 60°C an optional protective clear plastic tube is recommended as protection to the operator.

The cabinet dimensions are 31 x 16 x 21 inches high (79 x 41 x 53 cm). Shipping weight is 200 lbs, 27 cu.ft.

Model 177-4A is identical to Model 177-4D but uses an analog controller. Operating temperature range is ambient to 95°C. If operating above 60°C an optional protective clear plastic tube is recommended as protection to the operator.



▲ Model 177-4D

Also for Methods:

ASTM	D70, D287, D1298, D2111, D6822
IP	160, 189, 190
ISO	3838
DIN	12 791, 51 757, 52 004



▲ Model 28-1

Model 28-1 is a single position, stainless steel heated tube not requiring a glass hydrometer cylinder. The sample is poured directly into the stainless steel tube until the sample overflows the tube. Provisions are made for the overflow to be drained to waste. The hydrometer level is easily read at the sample's meniscus.

After measurement the drain valve is opened and the sample is discarded to a waste container or sink.

Model 28-1 has a temperature range of ambient to 150°C. The digital display controller with a resolution of 0.1°C provides temperature stability of $\pm 0.1^\circ\text{C}$.

Model 28-2 is the same as Model 28-1, but with two heated tube, each independently controlled with its own digital controller. The heated tubes temperature can differ by up to 40°C.

PROGRAMMABLE REFRIGERATED BATHS for POUR POINT STABILITY

- Operating Temperature 25° to -55°C
- Temperature Stability of $\pm 0.1^\circ\text{C}$
- Programmable Cooling Rate from 0.1° to 10°C per Hour
- Digital Indicating PID Temperature Controller
- Liquid Bath for Manual Testing
- Fully Automated Apparatus

Model 203C programmable liquid bath meets the specifications and requirements of FTM791, Test Method 203, Cycle C for testing Pour Point Stability of Lubricants. It can also be programmed for John Deere JDQ 71 and 74 Slow Cool Test, as well as for ASTM D4539 Low Temperature Flow Test (LTFT) (requires an addition of a beaker holding rack). It is also useful for any other test where programmed cooling and/or heating is specified.

The floor model liquid bath is mechanically refrigerated capable of operating from +25°C to -55°C. The digital programmable controller, displaying both set point and actual temperature, maintains the bath temperature within $\pm 0.1^\circ\text{C}$ of set point. The bath is protected against over heating in the event of primary controller failure. The fully insulated stainless steel bath with the top opening insulated cover has a capacity for 35 pour point test cells.

Cabinet dimensions are 28 x 36 x 43 inches high (70x 90x 108 cm). Shipping weight is 440 lbs, 41 cu. ft.

Model DR-203 is a two position instrument capable of automatically measuring the pour point stability as per FTM791-203C test method as well as pour point by ASTM D97. The instrument is similar to the automated pour point instruments described on page 10 and 11 with the addition of programmed cooling and heating routine as specified by Method 203, Cycle C and JDQ 71 Pour Point Stability Method.

Model DR-203 is directly refrigerated eliminating the need to pump cold alcohol from a bulky and noisy cryostat. The operating temperature range is from 25° to -70°C.

Other model are available with addition of automated cold filter plugging point (CFPP), freeze point and cloud point. Any number of analyzers can be accommodate in a mix or match combination from 1 to 4 test units.

Also for Methods:

ASTM	D4539
FTM	791-203 Cycle C
JDQ	71, 74



▲ Model 203C



▲ Model DR-203

FLOCK POINT DETERMINATION of REFRIGERATION OILS

- Conform to DIN 51 351
- Operating Temperature +15° to -70°C
- Temperature Stability of ±0.1°C
- Digital Indicating PID Temperature Controller
- Mechanically Refrigerated Liquid Bath

Model 29 is a full visibility, mechanically agitated liquid bath able to accept 9 test tubes as specified by DIN 51 531 test method for determination of flock point (compatibility) of refrigerants with refrigeration oils.

A digital indicating PID temperature controller with 0.1°C resolution provides stability and uniformity of ±0.1°C. Operating temperature range is from +15° to -70°C.

In the event of the primary controller failure a secondary controller prevents overheating.

The bath jar is an evacuated, unsilvered Dewar flask. The jar is back-lit by a fluorescent light to facilitate viewing of the oil/refrigerant in the test tubes. The jar is enclosed in a protective cabinet with a clear plastic viewing window.

Cooling is provided by mechanical refrigeration using ozone friendly refrigerants.

Model 31 is similar to Model 29 but its operating temperature range is from +15° to -40°C.

Also for Methods:

DIN	51 351
FTM	791-1303



▲ Model 31

DROPPING POINT OF GREASES

- Six Test Positions
- Heavily Insulated Heated Aluminum Block Bath
- Backlit for Excellent Viewing of Test Tubes
- Operating Temperature Range to 400°C
- Digital Indicating Controller

Model 388 conforms to ASTM D2265 Dropping Point of Greases test method. The insulated heated aluminum block enclosed in a cabinet has 6 test positions. Each test position has a viewing port and illumination for observation of the dropping point.

The operating temperature range is up to 400°C. Temperature control is provided a digital display controller with 0.1°C resolution. As a safety measure, a secondary controller interrupts power in the event of primary controller failure.

For Method:

ASTM	D2265
------	-------



▲ Model 388

AUTOMATED COLD SHEAR RHEOMETER

- Correlates to ASTM D5293 and D2602
- Compact Design with Extra Small Bench Top Footprint
- Integral Cooling without ANY Alcohol
- Integral PC and Touch Panel Screen
- Small Sample Size - 20 mL
- Self Cleaning
- Solvent Free Operation
- Self Compensating Rotor and Stator
- Very Low Power Consumption

Also for Methods:

ASTM	D2602, D5293
IP	350
DIN	51-377

Model CS2 Cold Shear Rheometer is specifically designed to correlate to Cannon's line of CCS cold cranking simulators, particularly to CC-5. It correlates to ASTM D5293 and D2602.

The compact design of Model CS2 includes an integral PC running on Windows NT4, a touch screen, an integral 18 sample carousel auto sample loader, and integral cooling with direct refrigeration using no alcohol. The sample loader carousel accepts 100 mL sample bottles.

This integral construction has a very small bench top footprint, only 24 x 24 x 15 inches high (61 x 61 x 38 cm). No external connecting cables are needed thus eliminating the frequent problem of cable disconnection or tampering.

The test requires less than 20 mL of test sample, including that needed for flushing of instrument with the next sample to be tested. No methanol or other solvents are required for this cleaning processes. Once the samples are placed on the carousel and identified in the PC, no further operator involvement is required. Additional samples can be loaded on the carousel as the tested samples are removed while the unit is operating.

The unique geometry of Model CS2 allows the calibration procedure to monitor and self-compensate for wear of the rotor and stator. This is particularly important when metal contaminated used oils are being tested.

Model CS2 offers multiple measurement modes, such as measuring its flow curve (shear stress vs. shear rate). The computer can control this precision rheometer under conditions of constant shear, constant shear rate, or constant speed. Model CS2 has been successfully used with gear oils down to -55°C.

This self compensating rotor and stator feature allows the adjustment of the rheometer to any future changes in the specifications of the test method.

Calibration is by means of industry standard calibration oils, but the unique design allows calibration with a single oil per temperature. It is also possible to calibrate the instrument with a SINGLE oil at a SINGLE temperature and still get data within better than the stated precision of D5293.



▲ Model CS-2

LOW TEMPERATURE CRYOSTAT for AUTOMATED COLD PROPERTY ANALYZERS

- Five Year Guarantee Against Compressor Failure
- Quick Replacement with In Stock Unit in Event of Failure
- Ideal Replacement for ISL, FTS, Julabo and Neslab Cryostats
- Cryostat for ISL, Herzog, PAC, ATPEM, Linetronic Automated Analyzers
Cloud Point, Pour Point, Freeze Point, CFPP

The typical petroleum products testing laboratory has been burdened by frequent cryostat failures which cool the automated cold properties analyzers. This shutdown in data production impacts the expense budget requiring testing by an outside lab as well as cost of replacement of the cryostat's compressor. Such cryostats are used to cool automated analyzers for cloud, pour, freeze point and CFPP. Many of these analyzers are made by ISL, Herzog, PAC, ATPEM, or Linetronic.

Model MRCC-5 is based on the technology used successfully for decades for cooling the cold crank simulator (CCS) and mini-rotating viscometer (MRV). The refrigeration system has been especially designed to provide added cooling capacity and, more importantly, a system of internal backup to guard against cooling failure.

Lawler now offers a cryostat with a 5 year iron clad guarantee against compressor failure. In the unlikely event of cooling failure, Lawler will ship (from stock) a replacement Model MRCC-5. In addition, repairs, freight, and associated costs will be borne by Lawler. Considering costs of operation disruption, the premium cost of Model MRCC-5 over competitive cryostats pays for itself just in a singular case of a compressor failure.

Model MRCC-5 has a sealed bath of approximately 3 gallons capacity, with a drain valve and with an integral pump delivering -80°C liquid to the analyzers. To reduce icing, a typical problem with cryostats, the bath is heavily insulated with 3 inches of rigid urethane foam plus foam rubber. Provision has been made for purging the bath with dry gas to extend the useful life of the bath medium thus reducing shutdowns as well as disposal

Also for Methods:

ASTM	D97, D2500, D2386, D6371
IP	350
DIN	51 597, 51 421
ISO	3013, 3015, 3016
FTM	791-201, 1411
NF	T60-105, M07-048



▲ Model MRCC-5

costs. The cryostat's operating temperature range is from -20° to -80°C. The bath temperature is maintained to ±0.5°C by a digital indicating controller with resolution of 0.1°C. A float provides protection in the event of low bath medium level event, such as a rupture in the lines delivering the cold liquid to the analyzers.

Model MRCC-5 is a compact, casters mounted, floor model cabinet with approximate dimensions of 30 x 26 x 34 inches high (76 x 66 x 86 cm).

REFRIGERATED COOLERS for AUTOMOTIVE LUBRICANTS TESTING

- Heavy-Duty Refrigerated Coolers for Use with:
Cold Cranking Simulator (CCS) by ASTM D5293 and D2602
Mini-Rotary Viscometer (MRV) by ASTM D3829 and D4684
- Can Cool both CCS and MRV Simultaneously

The refrigerated baths are specifically designed to cool the CCS (cold cranking simulator) and the MRV (mini rotary viscometer) as per ASTM D5293, D2602, and D3829, D4684, respectively.

Model MRCC-2 is a bench top cooler with a bath (13 liter) capable of accepting two pumps for simultaneous delivery of cooling fluid to either the CCS or MRV instruments. Its lowest operating temperature is -50°C.

Also for Methods:

ASTM	D2606, D3829, D4684, D5293
IP	350
DIN	51-377

Model MRCC-3 is similar to Model MRCC-2, but has two independent 6 liter baths, each independently controlled, sharing a common refrigeration system. This unit allows the simultaneous operation of two CCS instruments, or two MRV, or one CCS and one MRV instrument testing at widely different temperatures.

AUTOMATION APPARATUS for FILTERABILITY OF HYDRAULIC FLUIDS

- Fully Automated Apparatus
- Conforms to AFNOR NF E 48-690 and 48-691
- Windows PC Controlled

Model 377-1 and **Model 377-4** Hydraulic Oil Filterability Apparatus are 1 and 4 position, respectively, fully automated analyzer conforming to the AFNOR NF-E 48-690 and 48-691 test methods.

Each of the test positions is independently controlled by a Windows PC (not supplied). The proprietary software records the applied pressure, the first fluid drop collected, the level of fluid collected over time, and the temperature of the filtered sample. Data is stored up to the capacity of the hard drive and may be retrieved for spread sheet analysis, or downloaded to a LIMS.

Each position has a metal pressure container (ID 35 mm and 500 mL volume) with a screw on pressure cap and equipped with a 47 mm filter support. It can be easily disassembled for quick cleaning.

The first drop of the filtered sample is electronically detected and the level of the collected filtrate is recorded. In addition to detecting the first drop filtrate, a non-contact detector measures the filtered fluid level at 50 mL, 100 mL, 200 mL, and 300 mL.

Also for Methods:

IP	448
ISO	13357
NF	E 48-690, 48-691

After the operator fills the test oil into the pressure vessel, and presses start, the full operation is automated to the completion of test. An alarm sounds when the test is completed.



▲ Model 377-4

BOTTLE TUMBLER for HYDROLYTIC STABILITY OF HYDRAULIC FLUIDS

- Conforms to ASTM D2619 Test Method
- Temperature Range 30° to 110°C
- Temperature Stability of $\pm 0.5^{\circ}\text{C}$

Model 212-6 and **Model 212-12** are heated ovens for rotating six and twelve 200 mL bottles, respectively, at 93°C. The temperature stability of $\pm 0.5^{\circ}\text{C}$ is maintained by digital indicating PID controller.

The bottles are rotated at 5 rpm as specified by ASTM D2619. The rotational speed is digitally displayed and adjustable. An on-off switch is provided for the rotating rack. The rotating rack firmly holds sample bottles. The top opening insulated cover allows easy access.

The temperature uniformity is maintained by a forced air blower. A timer is provided that sounds a continuous alarm when the selected time has elapsed and the rotation is stopped.



▲ Model 212-6

APPARATUS for AIR RELEASE PROPERTIES of OILS

- **Conforms to ASTM D3427 Test Method**
- **Temperature Control of $\pm 0.1^{\circ}\text{C}$**
- **Over Pressure and Over Temperature Protection**
- **Precision Balance with PC Communications**

Also for Methods:

ASTM	D3427
ISO	9120
IP	313
DIN	51 381
NF	E48-614

Model 41 apparatus for determination of air release properties of oils meets the specifications of ASTM D3427 test method.

Model 41 consists of an air heating chamber with digital indicating temperature control, air pressure gauge, air pressure regulator, jacketed impinger test vessel, a glass bob with platinum wire, digital electronic balance with PC communication and facility at the bottom for the glass bob connection, and a heated recirculating bath. The recirculating bath provides $\pm 0.1^{\circ}\text{C}$ temperature control of the oil in the impinger vessel as well as for preheating of the glass bob.

Over temperature protection circuitry is provided in Model 41 in the event of primary controller failure. As another safety measure, pressure relief valve is provided to release pressure at 10 psig. The impinger vessel is supported on and adjustable up or down with a precision screw type platform to allow precise positioning of the glass bob within the test oil.

An automatic timer shuts down the flow after 7 minutes and sounds an alarm calling for the operator to insert the glass bob and measure the density.

OIL SEPARATION from GREASE

- **Meets The Requirements of ASTM D1742 and FTM 791-322**
- **Refrigerated and Heated Constant Temperature Cabinet**
- **Digital Temperature Control at $25^{\circ}\text{C} \pm 0.5^{\circ}\text{C}$**
- **Air Pressure Control**

Also for Methods:

ASTM	D1742
FTM	791-322

Models 375-4 and **375-6** have 4 and 6 positions, respectively, and meet the requirements of ASTM D1742 and FTM 791-322 Test Methods for Oil Separability from Grease During Storage.

The cabinet has an integral refrigeration compressor providing temperature control at $25^{\circ}\text{C} \pm 0.5^{\circ}\text{C}$ regardless of ambient temperature. Control is provided by a digital indicating controller with 0.1°C resolution showing set point and actual temperature. Forced air circulation provides uniform temperature within the cabinet.

Pressure to the pressure bleed test cells is regulated at 0.25 psi (1.72 kPa). The regulating system includes an air inlet pressure regulator with gauge, control valve for each cell, and a built in pressure relief system protecting against pressure surges. A shutoff valve is provided for each test cell allowing removal of one test cell without disturbing the other cells still under test.

Model 375-4 and 375-6 have 2 front opening doors and overall approximate dimension of 24 by 30 by 30 inches high.



▲ **Model 375-4**

HEATED TUBE BATHS for OXIDATION STABILITY TESTING

- Available for Any Oxidation or Heat Stability Test
- Heated Tubes Replace Aluminum Block and Oil Baths
- Each Position Individually Temperature Controlled
- Eliminates the Non-uniformity of Aluminum Blocks
- Eliminates Smoke and Fire Hazards of Oil Baths
- Light Weight vs Conventional Aluminum Blocks
- Rapid Heat Up and Cooldown
- Operating Temperature of 50° to 300°C
- Sample Temperature Stability of $\pm 0.1^\circ\text{C}$
- Oxygen or Air Flow Controller for Each Test Position
- Controllers May be Interfaced to a Windows Based PC
- Any Number of Positions from 1 to 100

The oxidation stability tube heating baths concept is similar to a heated aluminum block except that individual aluminum sleeves are used. Each sleeve is of a dimension to snugly fit a test tube of the specific test method requirements.

Each test position's sleeve is individually heated and controlled by a digital PID controller with test sample temperature stability of $\pm 0.1^\circ\text{C}$. The operating temperature range of is from $+50^\circ\text{C}$ up to $+300^\circ\text{C}$. The set point between any neighboring tube may differ by as much as $\pm 40^\circ\text{C}$, thus allowing simultaneous tests at varying temperatures in the same apparatus. The digital controller has a resolution of 0.1°C .

The great advantage of the heated tube bath vs. aluminum block baths is the ability to individually offset displayed tube temperature vs. actual sample temperature. This eliminates the position to position sample temperature non-uniformity typical with heated aluminum block baths.

By using several different sized sleeves, several test methods may be conducted in the same apparatus.

Windows based software is available that displays each position's temperature, each position temperature off-set, gas flow rate (if a mass flow controller is selected), and time from the beginning of the test. The temperature control PID parameters for each individual position can be optimized from the PC for greater temperature stability.

Also for Methods:

All Oxidation and Heat Stability Test Methods



▲ Model HT-342-2

DRY BATHS for OXIDATION STABILITY of OILS

- Individual Heated Tube Bath Conforming to ASTM D943
- Temperature Range 50° to 300°C
- Temperature Stability of $\pm 0.1^\circ\text{C}$
- Aluminum Block Bath Conforming to ASTM D943

Lawler offers a wide range of heated baths for the oxidation of oil products by ASTM D943, D2274, D2893*, D4310, and D4636 test methods. In addition to the conventional heated liquid baths Lawler offers solid aluminum block baths and the heated tube baths.

Model HT-342-28 has 28 heated tube positions conforming to ASTM D943 and related test methods. Each heated tube is of proper dimension to snugly fit the test tube. Each test position is individually temperature controlled with an indicating digital PID controller. Temperature stability of each position is $\pm 0.1^\circ\text{C}$. Temperature range is from $+50^\circ$ to $+300^\circ\text{C}$. Each tube's temperature may be independently adjusted so as to assure each sample temperature in each test position is identical. Model HT-342-28 has further flexibility allowing each test position to be at widely different temperatures. Each position has a over temperature cut off circuit in the event of primary controller failure. See page 42 for additional description of this design concept.

Each position has a float in tube flowmeter with a precision control valve for the delivering 3 ± 0.1 L/hr. of oxygen to the test sample. An adjustable pressure oxygen regulator is provided.

Model HT-342-12 is identical to Model HT-342-28, but has 12 heated tube test positions.

Model HT-342-2 is identical to Model HT-342-12, but has only 2 heated tube test positions. It is an economical bath for those laboratories with limited sample loads.

Model 30 is a floor model with a solid aluminum block bath with 12 test positions conforming to ASTM D943 test method. The single digital controller provides sample temperature control of $\pm 0.2^\circ\text{C}$. Temperature range is from 40° to 240°C .

Each position has a float in tube flowmeter with a precision control valve for the delivering 3 ± 0.1 L/hr. of oxygen at to the test sample. An adjustable pressure oxygen regulator is provided.

Specify if any model is to be used for ASTM D2893 test. The test requires a flowmeter delivering 10 ± 0.1 L/hr of air.

Also for Methods:

ASTM	D943, D2274, D2893, D4310, D4636
ISO	4263
IP	388
DIN	51 587
NF	M07-047, T60-150
AOCS	CD 12-57



▲ Model HT-342-12

LIQUID BATHS for OXIDATION STABILITY of OILS

- Liquid Baths Conforming to ASTM D943
- Temperature Stability of $\pm 0.2^{\circ}\text{C}$
- Temperature Range of 40° to 150°C
- Flowmeters with Precision Control Valve

Lawler offers a wide range of heated liquid baths for the oxidation of oil products conforming to a wide range of oxidation test methods.

Model 501-8 is a bench top heated liquid (oil or water) bath with 8 test positions conforming to ASTM D943 D2274, D2893, D4310, D6594 and related test methods. The digital indicating PID controller provides temperature stability and uniformity of $\pm 0.2^{\circ}\text{C}$. Temperature range is from 40° to 150°C . The heavily insulated stainless steel bath is agitated by an electrical motor for temperature uniformity.

An over temperature cut off circuit is provided in the event of primary controller failure.

Each test position has a float in tube flowmeter with a precision control valve for the delivering 3 ± 0.1 L/hr. of oxygen to the test sample.

Specify if Model 501-8 is to be used for ASTM D2893 test. The test requires a flowmeter delivering 10 ± 0.1 L/hr of air.

Overall dimensions of Model 501-8 are 22 x 18 x 23 inches high (55 x 45 x 58 cm).

Model 501-12 is identical to Model 501-8, but with 12 test positions.



▲ Model 501-8

Also for Methods:

ASTM	D943, D2274, D2893, D4310, D6594
ISO	4263
IP	388
DIN	51 587
NF	M07-047, T60-150
AOCS	CD 12-57



▲ Model 501-60

Model 501-60 is a liquid bath with 60 test positions arranged in 2 opposite banks of 30 positions each. The bath is configured as a floor model. Each position has a float-in-tube flow meter with a precision valve delivering 3 ± 0.1 L/hr. of oxygen. The flow meters are conveniently located in front of each test position. The water supply to each position has its own flow control valve and its own connection for the waste water.

The insulated bath is constructed of welded stainless steel and its water level is automatically controlled to the specified level. Temperature control is provided by a digital display controller with 0.1°C resolution. Bath stability is $\pm 0.2^{\circ}\text{C}$. Over temperature protection is provided to prevent over heating.

Model 501-30 is similar to Model 501-60, but with 30 test positions arranged in 2 banks of 15 positions each.

CHILLED WATER BATH for OXIDATION STABILITY of INSULATING OILS

- Recirculates Chilled Water to the Condensers
- Conserves Water
- Intended for High Volume Oxidation Testing

Laboratories with high volume of oxidation stability testing samples use large quantities of tap water to cool the reflux condensers. A more environmentally acceptable solution is to recirculate the cooling water such that the water exiting the last condenser is kept below 32°C. In addition, depending on location, tap water temperature may not be acceptable.

Model 65 is a refrigerated water bath of 30 gallons capacity capable of pumping 10°C water to up to 60 condensers. The flow rate is sufficient to maintain the exit water at the 60th condenser to be less than 32°C specified by the methods. Model 65 is a floor model mounted on casters. The bath temperature is controlled with a digital indicating controller providing bath temperature stability of ±1°C.

Model 16 is a bench top water chiller bath of 5 gallons capacity capable of delivering 10°C water to up to 24 condensers with water flow arranged in series. The flow rate and refrigeration capacity is such that the water exiting the last condenser does not exceed 32°C. Temperature control is provided by a digital indicating controller.



▲ Model 16

Also for Methods:

ASTM	D943, D2274, D4310, D4636, D4871, D6594
ISO	4263
IP	388
FTM	791-5307, 5308, 5321
DIN	51 587
NF	M07-047, T60-150



▲ Model 65

Model Y-20 is an electronic video recorder with a 6 inch color video screen storing data for transfer to a Windows based PC. These process values are saved in a data base format and may be used for further spread sheet analysis or transfer to a LIMS. Windows based proprietary software manages the above data and may be also used for configuration of the video recorder.

Sensors are provided for oxygen supply pressure, oxygen purity, bath temperature, and condenser water temperature. Alarms are configured to indicate deviation of any of the parameters outside predetermined limits. Oxidation tests are typically of long duration. Unrecognized failure in any of these parameters invalidates the results, requiring repeating of the test with a significant loss of time.

Oxygen Delivery System - Liquid oxygen handling and delivery systems as well as oxygen concentrators using room air to produce 99.5% purity oxygen gas are also available. Please inquire.

DRY BATH for CORROSIVENESS and OXIDATION STABILITY of HIGHLY REFINED OILS

- Individual Heated Tube Bath Conforming to ASTM D4636
- Temperature Range 50° to 400°C
- Temperature Stability of ±0.5°C
- Aluminum Block Bath Conforming to ASTM D4636

Also for Methods:

ASTM	D4636, D5968, D6594
FTM	791-5307, 5308
IHC	BT-10

Lawler offers a wide range of heated baths for the oxidation of oil products by ASTM D4636, D5968, and D6594 methods.

Model HT-10-6 has 6 heated tube positions conforming to ASTM D4636 and related test methods. Each heated tube is of proper dimension to snugly fit the test tube. Each test position is individually temperature controlled with an indicating digital PID controller. Temperature stability of each position is ±0.5°C. Temperature range is from +50° to +400°C. Each tube's temperature may be independently adjusted so as to assure each sample temperature in each test position is identical. Model HT-10-6 has further flexibility allowing each test position to be at widely different temperatures. Each position is protected against overheating in the event of primary controller failure. See page 42 for additional description of this design concept.

Each position has a float in tube flowmeter with a precision control valve for the delivering 10 ±1 L/hr. or 5 ±0.5 L/hr of air to the test sample.

Model 419-4 is a bench model with a solid aluminum block bath with 4 test positions conforming to ASTM D4636 test method. The single digital controller provides sample temperature control of ±0.5°C. Temperature range is from +50° to +400°C.



▲ **Model 419-4**

Each position has a float in tube flowmeter with a precision control valve for the delivering 10 ±1 L/hr. or 5 ±0.5 L/hr of air to the test sample.

Model 419-6 is similar to Model 419-4 but with 6 test positions.

Model 420-4 is a liquid bath with a capacity for 4 test tubes conforming to ASTM D6594 test method. Its operating temperature is 135°C. A digital indicating controller with a 0.1°C resolution maintains stability and uniformity of ±0.1°C. Four float in tube flowmeters with precision valve are supplied, each delivering 10 ±1 L/hr of dry air to the test sample."

Model 26 removes moisture from pressurized house air and is equipped with an electronic sensor measuring the dew point. The standard procedure of ASTM D4636 and D6594 test methods specify that dry air with a dew point of -68°C be used for testing.

Model 33 humidifies air to 10 ±1 mg/L of air and is equipped with an electronic sensor measuring water content. Alternative Procedures 1 and 2 of ASTM D4636 test method may specify that humidified air be used for testing.



▲ **Model 419-6**

UNIVERSAL OXIDATION DRY BATHS for OXIDATION and THERMAL STABILITY

- Aluminum Block Bath Conforming to ASTM D4871
- Individual Heated Tube Bath Conforming to ASTM D4871
- Temperature Range 50° to 400°C
- Temperature Stability of $\pm 0.5^{\circ}\text{C}$

For Method:

ASTM	D4871
------	-------

Model 66-6 is a bench top model with a solid aluminum block bath with 6 test positions conforming to ASTM D4871 test method. The single digital controller provides sample temperature control of $\pm 0.5^{\circ}\text{C}$. Temperature range is from 50° to 400°C.

Each position has a float in tube flowmeter with a precision control valve for delivering gas to the test specimen at a rate of from 1.5 to 13 L/hr. Please specify the gases to be used and their intended flow rates. Gas pressure regulator is provided to adjust the inlet gas pressure to the flowmeters. An over temperature control circuit is provided to prevent over temperature conditions in the event of primary controller failure.

Model 66-12 is similar to Model 66-6 but with 12 test positions.

Model HT-99-6 has 6 heated tube positions conforming to ASTM D4871 test method. Each heated tube is of proper dimension to snugly fit the test tube. Each test position is individually temperature controlled with an indicating digital PID controller. Sample temperature stability of each position is $\pm 0.1^{\circ}\text{C}$. Temperature range is from +50° to +400°C. Each tube's temperature may be independently adjusted so as to assure identical sample temperature in each test position. Model HT-99-6 has further flexibility allowing each test position to be at widely different temperatures. Each position is protected against overheating in the event of primary controller failure. See page 42 for additional description of this design concept.

Each position has a float in tube flowmeter with a precision control valve for delivering gas to the test specimen. Please specify the gases to be used and their flow rates.



▲ Model 66-12

CIGRE OXIDATION DRY BATHS for OXIDATION STABILITY of MINERAL OILS

- Aluminum Block Bath or Individual Heated Tube Baths
- Conforming to IP 48, 280, 306, 307, 331, and 335
- Precision Control Valve Flowmeters
- Temperature Range +50° to +250°C
- Temperature Stability of ±0.2°C

Also for Methods:

IP	48, 280, 306, 307, 331, 335
----	-----------------------------

Model 367-12 is a bench top model with a circular solid aluminum block bath with 12 test positions arranged in a circle. Model 367-12 conforms to IP 48, 280, 306, 307, 331, and 335 test methods. The single digital controller provides temperature control of ±0.2°C and position to position temperature uniformity of ±0.2°C. Temperature range is from +50° to +250°C.

Each test position accepts the associated absorption tube in its own support attached to the top. Twelve float in tube flowmeters are provided mounted on a support rack. A central post holding gas flow tubes simplifies the management of the tubes. With the standard model the air flow is controlled with a precision valve at 1 ±0.1 L/hr to each position. For IP 48 the air flow is controlled at 15 ±0.25 L/hr. Please specify if the bath is for IP 48 test method. A gas pressure regulator is provided to adjust the inlet gas pressure to the flowmeters. An over temperature control circuit is provided to prevent over temperature conditions in the event of primary controller failure.

Model 367-4 is similar to Model 367-12 but with only 4 test positions.



▲ Model 367-12



▲ Model 367-4

Model HT-101-20 heated tube has 20 test positions conforming to IP 48, 280, 306, 307, 331, and 335 test methods. Each heated tube is of proper dimension to snugly fit the test tube. Each test position is individually temperature controlled with an indicating digital PID controller. Temperature stability of each position is ±0.1°C. Temperature range is from +50° to +300°C. Each tube's temperature may be independently adjusted so as to assure identical sample temperature in each test position.

Model HT-101-20 has further flexibility allowing each test position to be at widely different temperatures. Each position has a over temperature cut off circuit in the event of primary controller failure. See page 42 for additional description of this design concept.

Each position has a float in tube flowmeter with a precision control valve for delivering gas to the test specimen at 1 ±0.1 L/hr to each position. For IP 48 the air flow is controlled at 15 ±0.25 L/hr. Please specify if the bath is for IP 48 test method.

OXIDATION STABILITY of FUELS

- **Liquid Bath with Capacity for 6 Oxidation Bombs**
- **Solid Aluminum Block Bath with Capacity for 4 Bombs**
- **Temperature Range 40° to 150°C**
- **Temperature Stability of $\pm 0.1^\circ\text{C}$**

Model 188 is a liquid bath conforming to ASTM D525, D873, D5304 and related test method for the oxidation stability of gasoline (Induction period method) and aviation fuels (Potential residue method). Model 188 has a capacity for 6 oxidation bombs. The temperature range is 40° to +150°C with temperature stability of $\pm 0.1^\circ\text{C}$ provided by a digital indicating controller with 0.1°C resolution. Mechanical agitation of the liquid bath is provided to insure temperature uniformity within the bath. The bath has a volume capacity of approximately 160 liters.

The unit is protected against overheating in the event of primary controller failure.

Model 144 is a circular solid aluminum block accepting 4 oxidation bombs. Operating temperature range is 40° to +200°C. A digital indicating controller with 0.1°C resolution provides temperature stability and position to position uniformity of $\pm 0.1^\circ\text{C}$.

Also for Methods:

ASTM	D525, D873, D5304
ISO	7536
IP	40, 138
FTM	791-3352, 3354
DIN	51 780



▲ **Model 144**

LIQUID BATH for OXIDATION STABILITY of INSULATION OILS

- **Conforms to ASTM D2440 Method**
- **Temperature Stability of $\pm 0.2^\circ\text{C}$**
- **Temperature Range of 40° to 150°C**
- **Flowmeters with Precision Control Valve**

Model 505-8 is an oil bath with 8 test positions accepting ASTM D2440 test tubes and with 8 float in tube flowmeters and precision control valve delivering oxygen at 1 ± 0.1 L/hr. It operates at 110°C with $\pm 0.2^\circ\text{C}$ stability.

The heavily insulated stainless steel bath is agitated by an electrical motor for temperature uniformity. An over temperature cut off circuit is provided in the event of primary controller failure.

Model 505-4 is similar to Model 505-8 but with only 4 test positions.

For Method:

ASTM	D2440
------	-------



▲ **Model 505-8**

RUSTING CHARACTERISTICS of OILS

- Liquid Bath or Dry Block Bath with 4 or 6 Test Positions
- Temperature Range 40° to 150°C
- Temperature Stability of $\pm 0.1^\circ\text{C}$

Model 390-6 is a 6 test positions agitated liquid bath conforming to ASTM D665, D3603, and other similar tests. A two position bath cover is provided that adjusts for either ASTM D665 or D3603 test methods. The bath's temperature is maintained by a microprocessor based PID controller with set point and bath temperature display. A secondary high temperature limit switch prevents over heating in the event of primary controller failure. In addition, a float switch is provided that interrupts power to the heaters in the event of low bath liquid level.

The stainless steel bath is provided with a drain for easy replacement of the bath medium. The test beakers rest on a perforated support rack at the test specified level.

The stainless steel stirrers are driven by an adjustable synchronous motor to assure an exact speed of 1000 rpm. The individual stirrers are belts driven. A digital tachometer is provided displaying the rotational speed of the stirrers. An adjustable digital timer automatically turns off the stirrers.

The stirrers may be switched off without interrupting power to the bath. Individual stirrers have the ability to be lifted out of the test beaker by simply loosening the knurled holding nut and lifting from the beaker. When lifted, the stirrer shaft protrudes through the top of the apparatus, allowing full and easy access to the test beaker.



▲ Model L636

Also for Methods:

ASTM	D665, D3603
ISO	7120
IP	135
FTM	791-4011, 791-5315
DIN	51 355, 51 585
NF	T60-151



▲ Model 390-4

A clear plastic safety guard is available as an option on the front of the apparatus protecting the operator from the rotating stirrer shafts.

Model 390-4 is identical to Model 390-6 but with only 4 test positions.

Model 396-6 is a solid aluminum block heated bath with the same features as Model 390-6, however, it is not adjustable between ASTM D665 and D3603. Specify the intended method to be used. The advantage of the solid aluminum heated block bath over a liquid bath is the safety with the elimination of fumes and fire hazards of the bath medium.

Model 396-4 is identical to Model 396-6 but with only 4 test positions.

Model L636 is the polishing device specified by ASTM D665. It consists of a motor rotating the chuck at 1700 to 1800 rpm. The design of the chuck is as specified by the test method. A protective cover is provided over the motor.

RUSTING CHARACTERISTICS of OILS

- Semi Automated Operation
- Reduces Operator Errors
- Improved Precision
- Liquid Bath or Dry Block Bath with 4 or 6 Test Positions
- Temperature Range 40° to 150°C
- Temperature Stability of ±0.1°C

Also for Methods:

ASTM	D665
ISO	7120
IP	135
FTM	791-4011, 791-5315
NF	T60-151

Model 391-6 is an agitated liquid bath with 6 test positions conforming to ASTM D665 and other similar tests. The bath is in all respects the same as Model 390 apparatus (see facing page 50), but with the addition of timing features that make it a semi automated apparatus. Operator timing errors are thus reduced and the data precision is improved.

The operator adds 30 mL of water into each of the 6 reservoirs above each of the beakers.

The operator prepares and inserts the beakers (with test oil, covers, and stirrers) into the bath as per ASTM D665 method. The test rod assembly (includes the steel rod and holder) are mounted on a holding rack above the individual beakers. The stirrers and the timer are started.

When the test oil temperature reaches 60°C (as detected by one PT100 temperature probe inserted into one of the test beakers), the steel rod holding rack is lowered such that the steel specimens are inserted into the beaker and test oil as per ASTM D665.

After 30 minutes of agitation, the 30 mL of water is released into the beakers. After 60 minutes of agitation the holding rack with the steel test rods is raised from the beakers, the stirrers are stopped and an alarm alerts the operator. The timers are reset for the next test. The steel rods are now ready for visual observation of rusting.

Model 391-4 is identical to Model 391-6 but configured for only 4 test positions.

Model 397-6 is a 6 position dry block bath also available with same automation features as Model 391-6. The dry block bath removes the disadvantages of liquid baths, such as smoke, fire hazard, cleanliness, safety, etc.

► AVAILABLE MODELS

Model No.	Description	ASTM Test Method
390-6	6 Position liquid bath	D665 and D3606
390-4	4 Position liquid bath	D665 and D3603
391-6	Automated 6 position liquid bath	D665
391-4	Automated 4 position liquid bath	D665
396-6A	6 position aluminum block bath	D665
391-6B	6 position aluminum block bath	D3603
391-4A	4 position aluminum block bath	D665
391-4B	4 position aluminum block bath	D3603
397-6	Automated 6 position aluminum block bath	D665
397-4	Automated 4 position aluminum block bath	D665
L636	Polishing device with chuck	D665 and D3603

COPPER CORROSION by PETROLEUM PRODUCTS

- Solid Block Constant Temperature Baths
- Liquid Constant Temperature Baths
- Baths for Tube or Test Bomb
- Temperature Range 30° to 180°C
- Temperature Stability of ± 0.2 °C

Also for Methods:

ASTM	D130, D4814
ISO	2160
IP	154
FTM	791-5325
DIN	51 759
NF	M07-015

Lawler offers a wide range of constant temperature test baths conforming to ASTM D130 copper corrosion test for fuel and related test methods. Liquid baths are offered with capacity for 4, 8, or 12 test bombs held in a vertical position. The same baths may also be used (with a change of support rack) for test tube only procedure accommodating 8, 16, or 24 test tubes.

Model 279-4 is a stainless steel liquid bath able to accept 4 test bombs for either D130 test method. By exchanging the support rack it is able to accept 8 test tubes from D130 when the test bomb is not employed.

The temperature range of Model 279-4 is 40° to +180°C with temperature stability of ± 0.2 °C. Temperature is controlled with a digital display controller with 0.1°C resolution. To prevent over heating in the event of primary controller failure, a high limit switch is provided to interrupt power to the bath. A float switch interrupts power to the bath in the event of low bath fluid level.

The bath is mechanically agitated to insure test point to test point uniformity. A cover over the bath is provided to reduce evaporation (if water is used as a bath medium).

Model 279-8 and **Model 279-12** are identical to Model 279-4 except are larger and able to accept 8 and 12 test bombs, respectively, or 16 and 24 test tubes, respectively.

Models 279-4, 279-8, and 279-12 are also suitable for the proposed new silver corrosion test method that will soon be part of ASTM D4814 gasoline specification. See page 53.

Model 280-8 and **Model 280-12** are solid aluminum block baths with 8 and 12 test tube positions, respectively, for ASTM D130 where the use of the test tube alone is specified without the test bomb. The operating temperature range is 30°C to 180°C. The dry block bath removes the disadvantages of liquid baths, such as smoke, fire hazard, cleanliness, safety, etc.

Accessories for ASTM D130, such as test bombs, polishing vice, copper or silver test strips, ASTM color standard, etc. are available conforming to the test method.



▲ Model 280-8

SILVER CORROSION by PETROLEUM PRODUCTS

- Solid Block Constant Temperature Baths
- Liquid Constant Temperature Baths
- Temperature Range 30° to 180°C
- Temperature Stability of ± 0.2 °C
- Liquid Bath Conforming to the New ASTM Silver Corrosion Method

Also for Methods:

ASTM	D4814
IP	227

Recent developments have accelerated the ASTM development of a silver corrosion test by fuels. The new ASTM method will soon be made part of ASTM D4814 and is, in large measure, based on D130 test bomb method.

Model 279-4 is an insulated stainless steel liquid bath able to accept 4 test bombs holding the test fuel and the silver strip. The temperature range of Model 279-4 is 30° to 180°C with temperature stability of ± 0.2 °C. Temperature is controlled with a digital display controller with 0.1°C resolution. To prevent overheating, a high limit switch is provided to interrupt power to the bath in the event of primary controller failure. A float switch interrupts power to the bath in the event of low bath fluid level.

The bath is mechanically agitated to insure test point to test point uniformity. A cover over the bath is provided to reduce evaporation (if water is used as a bath medium).

Model 279-8 and **Model 279-12** are identical to Model 279-4 except are larger and able to accept 8 and 12 test bombs, respectively.

Model 279-4, 279-8 and 279-12 are also suitable for ASTM D130 method when pressure vessels are used. See page 52.

Model 291-6 is an insulated stainless steel liquid bath deep enough to be able to accept 6 test tubes conforming to IP 227 silver corrosion test method. The temperature range of Model 291-6 is 30° to 180°C with temperature stability of ± 0.2 °C. Temperature is controlled with a digital display controller with 0.1°C resolution. To prevent overheating, a high limit switch is provided to interrupt power to the bath in the event of primary controller failure. A float switch interrupts power to the bath in the event of low bath fluid level.

Model 295-6 with similar features as Model 291-6 but is a solid aluminum block bath deep enough to accept 6 test tubes (350 mm long) as per IP 227. The dry block bath removes the disadvantages of liquid baths, such as smoke, fire hazard, cleanliness, safety, etc.



▲ Model 295-6

LEAD CORROSION by PETROLEUM PRODUCTS

- Meets the Requirements of FTM 791-5321
- Automated Stirrer Timing
- Automated Raising and Lowering of Stirrers
- Temperature Range 40° to 200°C
- Temperature Stability of ± 0.1 °C

Model 416-3 is a 3 position fully insulated stainless steel oil bath with an operating range from 40° to 200°C. Temperature control is provided by digital indicating controller providing stability of ± 0.1 °C. Built in support rack holds the test tube to the proper immersion level. Each position is equipped with a stirrer at 600 +/- 50 rpm for rotating the copper and lead specimens in the test oil.

For improved operator efficiency, Model 416-3 is semi automated. After the test tube with the test oil is placed in the bath, there is a 30 minutes wait as specified by the method. At this point, the stirrers are automatically lowered into the samples, and automatically start rotating at the correct speed. The air flow also starts at the same time. After 60 minutes of operation, the stirrers are automatically stopped, raised from the oil, the air flow is stopped and an alarm sounds.

The remaining time to the next event is digitally displayed as well as the stirrer speed. Both the stirrer speed and event timer are adjustable, if so desired.

Each test position has a ball-in-tube flow meter with precision valves providing 2 cubic feet per hour air flow. The flow meters are mounted on the front of the cabinet for easy of adjustment. As an option, mass flow controllers are available providing precise air flow independent of air temperature or pressure.

To prevent over heating in case of primary controller failure a redundant temperature controller disconnects power to the heaters. A low bath liquid level detector also disconnects power to the heaters.

The overall dimensions of Model 416-3 are 810 x 65 x 1140 mm (32 x 25 x 45 inches) LWH.

Model 416-6 is identical to Model 416-3 but with 6 test positions.

Model 416-M is similar to Model 416-6 with 6 test positions but without the automated feature of raising, lowering, starting and stopping of the stirrers and air flow.

Model 393-6 is a six position aluminum block bath, similar to Model 416-3 but without the automation features. The aluminum block bath offers improved safety over a liquid bath.

For Method:

FTM	791-5321
-----	----------



▲ Model 416-3



▲ Model 393-6

RUST TESTING in HUMIDITY CABINET

- **Conforms to ASTM D1748 and FTM 791-5329**
- **Automated Water Level Control**
- **Automated Hood Opening with Timer**
- **Capacity for 33 Test Panels**
- **Temperature Stability of ± 0.5 °C**

Also for Methods:

ASTM	D1748
FTM	791-5329

Model 423 Humidity Cabinet conforms to the design and specifications of ASTM D1748 and FTM 791-5329 test methods for measuring rust protection of metal preservatives. The rack rotating at 0.33 ± 0.03 rpm has a capacity for 33 test panels. The cabinet's humidity environment is maintained at $48.9^{\circ}\text{C} \pm 1^{\circ}\text{C}$ by a digital indicating controller. Air flow to the 20 spargers below the water level is metered at 31 ± 1 cu ft/hr by a float in glass tube flowmeter (mass flow controller is available as an option).

A secondary controller of the water temperature acts as a safety over temperature limit in the event of primary controller failure.

The bath and internal construction is all stainless steel. The outside cabinet construction is of anodized aluminum frame and painted aluminum panels. The cabinet is mounted on lockable casters for ease of positioning in the lab. The distilled water level within the bath is automatically maintained at 8 inches. The bath has a 94 liter capacity. A pan collects the drippings from the test panels and is drained to the outside.

The light weight, hinged cover has two layers of airplane cloth (as specified by ASTM D1748). As an option for Model 423 humidity cabinet, a timer and mechanism is provided that automatically opens and closes the cover to the specified angle of opening and for the required exactly 15 minutes and 5 minutes every day at the same time of day (except Saturdays and Sundays). An alarm alerts the operator as the



▲ **Model 423**

cover is opening. This feature assures that the test method is followed more carefully, relieving the operator from this repetitive task.

Model DB-1 is the panel draining box as is specified in Fig A1.4 of ASTM D1748 test method. For an extended useful life, it is constructed of anodized aluminum for the frame and painted aluminum side panels. It conforms in all other respects to ASTM D1748 method.

► ACCESSORIES

Part No.	Description
AH-1	Automated Hood Opening Mechanism with Timer
HC-1	Replacement aluminum oxide air diffuser stone.
HC-2	Replacement airplane cloth for the cover of Model 423.
HC-3	Aluminum oxide (240 grit) cloth for panel preparation.
HC-4	Steel test panels with 51 x 102 x 3.2 mm dimension and a weight of 110 grams. The panels are fabricated from open-hearth, "killed" type low carbon, No. 4 soft temper, cold rolled steel.
HC-5P	Polymethyl methacrylate dummy panels.
HC-5S	Stainless steel dummy panels.
HC-6	Stainless steel suspension hooks for the test panels.

ASPHALT OXIDIZING REACTOR

- Asphalt Oxidation for Roofing Materials
- Small Compact Size
- Operating Range to 300°C
- Motor Driven Agitator
- Efficient Air Sparger

Model 90 asphalt oxidizing reactor is designed expressly for the study of oxidation of asphalt at elevated temperatures for the manufacture of roofing materials.

Model 90 is an all stainless steel, approximately 4 inch internal diameter by approximately 18 inch tall, electrically heated reactor with a mixer, an efficient air sparger for maximum gas dispersion, and a bottom drain valve.

The reactor cover has provisions for venting the off-gases and for reactor loading. The sparger, thermocouple and mixer are removable from the reactor cover to facilitate cleaning. The bottom drain has a special ball valve trapping a minimum volume of reactants, allowing the full reactor charge to be efficiently mixed. The reactants are agitated by twin turbine mixers operated by a controllable variable speed motor. The electrically heated and insulated stainless reactor may be lifted from the stand for easier cleaning.



▲ Model 90

The reactants' temperature is controlled by a digital indicating, PID temperature controller. The operating temperature is up to 300°C. A temperature limit control is provided, preventing over heating. The airflow is controlled by a precision needle valve and measured by a rotary flowmeter capable of from 0 to 10 liters per minute of air. An air pressure regulator is also provided.

FOAMING TENDENCY of ENGINE COOLANTS

- Conforms to ASTM D1881
- Operates at 88°C with $\pm 0.5^\circ\text{C}$ Stability

For Method:

ASTM D1881

Model 98-1 and **Model 98-2** (one and two test positions, respectively) meet the requirements ASTM D1881 Foaming Tendency of Engine Coolants test method.

The 12 inch diameter borosilicate glass jar is temperature controlled at 88°C with a stability and uniformity of $\pm 0.5^\circ\text{C}$. The temperature controller has an over temperature protection in the event of primary controller failure. A ball in tube flow meter with a precision control valve is provided for each test position. The air flow rate is controlled at 1000 ± 25 mL/min.



▲ Model 98-1

EFFECT of LIQUIDS or AIR on RUBBER PROPERTIES

- Conforms to ASTM D471 and D865 Methods
- Temperature Range 40° to 300°C
- Sample Temperature Stability of $\pm 0.1^\circ\text{C}$
- Each Position's Temperature Individually Controlled
- Rapid Heat Up and Cool Down
- Replaces Aluminum Block Baths and Liquid Baths

Model 359-28 is based on the heated tube bath concept as described on page 42. The concept is similar to a heated aluminum block bath except that individual aluminum sleeves are used. The sleeve is sized to snugly fit a test tube of the specific test method requirements.

Model 359-28 has 28 test positions for test tubes conforming to either ASTM D471 or D865 test methods. Each test position's sleeve is individually heated and individually controlled with a sample temperature stability of $\pm 0.1^\circ\text{C}$. Each position has its own individual digital PID controller with 0.1°C resolution. The set point between any neighboring tube may differ by as much as $\pm 40^\circ\text{C}$, thus allowing tests at varying temperatures in the same apparatus. The advantage of individual controllers is that each position's temperature may be adjusted so that the sample temperature is identical to any other.

Model 359-28 is of light weight compared to an aluminum block of comparable test sample capacity. The small mass of the tubes allows for rapid heat up or cool down as compared to other bath designs.

Aluminum block baths suffer from position to position temperature non-uniformity without the ability to make adjustments. Liquid baths at elevated temperature suffer from the safety issues such as smoke, fire, housekeeping problems from oil dripping, need for frequent oil changes, etc.

Models similar to Model 359-28 but with of varying test capacity are available to meet individual needs.

Also for Methods:

ASTM D471, D865



▲ Model 359-28



▲ Model 359-28 Software Screen

► INDEX by ASTM TEST METHODS

ASTM D97 : Pour point	10-13
ASTM D130 : Copper Corrosion Test	52
ASTM D287 : API Gravity	35
ASTM D445 : Kinematic Viscosity	8, 9
ASTM D471 : Rubber Property in Liquids	57
ASTM D525 : Oxidation Stability of Fuels	49
ASTM D613 : Cetane Engine Automation	26, 27
ASTM D665 : Rusting Properties of Oils	50, 51
ASTM D865 : Rubber Deterioration in Air	57
ASTM D873 : Oxidation of Aviation Fuels	49
ASTM D892 : Foaming Tendency of Oils	28-32
ASTM D943 : Oxidation Stability of Oils	42-45
ASTM D1177: Freeze Point of Engine Coolants	15
ASTM D1298 : Specific Gravity	35
ASTM D1319 : Hydrocarbon Types by FIA	20
ASTM D1401 : Water Separability of Oils	34
ASTM D1478 : Grease Torque Test	33
ASTM D1742 : Oil Separation from Grease	41
ASTM D1748 : Humidity Cabinet	55
ASTM D1881 : Foaming of Engine Coolants	56
ASTM D2170 : Asphalt Viscosity	9
ASTM D2171 : Asphalt Viscosity	9
ASTM D2265 : Dropping Point of Grease	37
ASTM D2274 : Distillates Oxidation Stability	42-45
ASTM D2386 : Freezing Point of Jet Fuels	15
ASTM D2440 : Oxidation Stability of Oils	49
ASTM D2500 : Cloud Point	10-13

ASTM D2532 : Low Temp Kinematic Viscosity	8
ASTM D2602 : Cold Crank Simulator	38
ASTM D2619 : Hydrolytic Stability Test	40
ASTM D2699 : Octane Engine Automation	22-25
ASTM D2700 : Octane Engine Automation	22-25
ASTM D2885 : Octane Engine Automation	25
ASTM D2893 : Oxidation of Distillates	42-45
ASTM D2983 : Low Temp Brookfield Viscosity	4-7
ASTM D3427 : Air Release Properties	41
ASTM D3603 : Rusting Properties of Oils	50, 51
ASTM D3829 : Chillers for Auto Lubricants	39
ASTM D4310 : Oxidation Stability of Distillates	42-45
ASTM D4539 : Low Temp Filterability Test	18, 19
ASTM D4636 : Oxidation Stability	46
ASTM D4684 : Chillers for Auto Lubricants	39
ASTM D4693 : Low Temp Grease Torque	33
ASTM D5293 : Cold Crank Simulator	38
ASTM D5853 : Pour Point of Crude Oils	12, 13
ASTM D5968 : Distillates Oxidation	42-45
ASTM D6082 : Foaming Tendency of Oils	28-32
ASTM D6074 : Specific Gravity	35
ASTM D6158 : Specific Gravity	35
ASTM D6371 : Cold Filter Plugging Point	14, 15
ASTM D6422 : Gasoline Phase Separation	12, 13
ASTM D6468 : Stability of Distillate Fuels	21
ASTM D6594 : Oxidation Stability	42-45
ASTM E128 : Permeability and Porosity of Diffusers	31

► INDEX by ISO TEST METHODS

ISO 2160 : Copper and Silver Corrosion	52
ISO 3013 : Jet Fuel Freezing Point	15
ISO 3015 : Cloud Point	10-13
ISO 3016 : Pour Point	10-13
ISO 3104 : Kinematic Viscosity	8, 9
ISO 3675 : Specific Gravity	35
ISO 4263 : Oxidation Stability	42-45
ISO 5164 : Knock Characteristics	22-25

ISO 6614 : Water Separability	34
ISO 7120 : Rusting Properties of Oils	50, 51
ISO 7536 : Oxidation Stability of Fuels	49
ISO 9262 : Low Temp Brookfield Viscosity	4-7
ISO 12205 : Oxidation Stability	42-45
ISO 13357 : Filterability of Hydraulics	40
ISO 13757 : Hydrocarbon Types by FIA	20
ISO 17025 : Specific Gravity	35

► INDEX by MISCELLANEOUS TEST METHODS

AOCS CD 12-57: Oxidation Stability and Corrosion	42-44
IHC BT-10 : Oxidation and Corrosion	46
John Deere JDQ 74: Low Temp Oil Fluidity	36
EN 116 : Cold Filter Plugging Point	14

John Deere JDQ 71: Pour Point Stability	36
UOT: Oxidation Stability and Corrosion	42-44
CEC-L-18A	4, 5

► INDEX by IP TEST METHODS

IP 15 : Cloud Point	10-13
IP 16 : Jet Fuel Freezing Point	10, 15
IP 40 : Oxidation Stability of Fuels	49
IP 48 : Oxidation Stability of Oils	48
IP 71 : Kinematic Viscosity	8, 9
IP 135 : Rusting Properties of Oils	50, 51
IP 138 : Oxidation Stability of Gasoline	49
IP 146 : Foaming Tendency of Oils	28-32
IP 154 : Copper and Silver Corrosion	52
IP 156 : Hydrocarbon Types by FIA	20
IP 160 : Specific Gravity	35
IP 219 : Pour Point	10-13

IP 227 : Silver Corrosion	53
IP 237 : Knock Characteristics	22-25
IP 267 : Low Temp Brookfield Viscosity	4-7
IP 280 : Oxidation Stability	48
IP 306 : Oxidation Stability	48
IP 307 : Oxidation Stability	48
IP 309 : Cold Filter Plugging Point (CFPP)	10, 14
IP 313 : Air Release Properties	41
IP 319 : Kinematic Viscosity	8, 9
IP 331 : Oxidation Stability	48
IP 335 : Oxidation Stability	48
IP 448 : Filterability of Hydraulic Fluids	40

► INDEX by DIN TEST METHODS

DIN 51 351 : Flock Point or Refrigeration Oils	37
DIN 51 352 : Oxidation Stability	49
DIN 51 355 : Rusting Properties of Oils	50, 51
DIN 51 373 : Oxidation Stability	49
DIN 51 381 : Air Release Properties	41
DIN 51 394 : Oxidation Stability & Corrosion	42-44
DIN 51 421 : Jet Fuel Freezing Point	10, 15
DIN 51 428 : Cold Filter Plugging Point	10, 14
DIN 51 352 : Oxidation Stability	49
DIN 51 550 : Kinematic Viscosity	8, 9

DIN 51 566 : Foaming Tendency of Oils	28-32
DIN 51 586 : Oxidation Stability and Corrosion	42-44
DIN 51 587 : Oxidation Stability & Corrosion	42-44
DIN 51 597 : Cloud and Pour Point	10-13
DIN 51 599 : Water Separability	41
DIN 51 757 : Specific Gravity	35
DIN 51 759 : Copper and Silver Corrosion	52
DIN 51 780 : Oxidation Stability of Fuels	49
DIN 51 799 : Oxidation of Fuels	49

► INDEX by FTM TEST METHODS

FTM 791-201 : Cloud and Pour Point	10-13
FTM 791-203 : Pour Point Stability	36
FTM 791-305 : Kinematic Viscosity	8, 9
FTM 791-322 : Oil Separation from Grease	41
FTM 791-334 : Grease Torque Test	33
FTM 791-1303: Flock Point of Refrigeration Oils	37
FTM 791-1411 : Jet Fuel Freezing Point	10, 15
FTM 791-3201 : Water Separability	41
FTM 791-3211 : Foaming Tendency of Oils	28-32

FTM 791-3213 : Foaming Tendency of Oils	28-32
FTM 791-3352 : Gasoline Oxidation Stability	49
FTM 791-3354 : Aviation Fuel Stability	49
FTM 791-3470 : Oil Homogeneity, Miscibility	12, 13
FTM 791-5307 : Corrosion and Oxidation Stability	42-44
FTM 791-5308 : Corrosion and Oxidation Stability	42-44
FTM 791-5321 : Corrosion of Lead by Oils	54
FTM 791-5325 : Copper and Silver Corrosion	52
FTM 791- 6002 : Knock Characteristics	22-25
FTM 791- 6005 : Knock Characteristics	22-25

► INDEX by AFNOR TEST METHODS

NF E 48-614 : Air release Properties	41
NF E 48-691 : Filterability of Hydraulic Fluids	40
NF E 48-690 : Filterability of Hydraulic Fluids	40
NF M 07-012 : Oxidation Stability of Fuels	49
NF M 07-013 : Oxidation Stability of Fuels	49
NF M 07-015 : Copper Corrosion	52
NF M 07-024 : Hydrocarbon Types by FIA	20
NF M 07-047 : Oxidation Stability	42-44

NF M 07-048 : Jet Fuels Freezing Point	10, 15
NF T 60-100 : Kinematic Viscosity	8, 9
NF T 60-105 : Cloud and Pour Point	10-13
NF T 60-125 : Water Separability	41
NF T 60-129 : Foaming Tendencies	28-32
NF T 60-150 : Oxidation Stability	42-45
NF T 60-151 : Rusting Properties of Oils	50, 51

ALPHABETICAL INDEX

Aircraft Turbine Engine Lubricants Corrosives and Oxidation	42-44	Cloud Point of Petroleum Oils	
Air Release Value (Impinger Method)	41	Automated Analyzers.....	10, 11
Antirust Properties of Petroleum Products	50, 51	Baths for Manual Testing.....	12, 13
API Gravity	35	Data Capture for Manual Testing.....	17
Asphalt		Cold Crank Simulator for Engine Oils	38
Oxidation Reactor.....	56	Cold Filter Plugging Point of Fuels	
Vacuum Controller for Viscosity of.....	21	Automated Analyzers.....	10, 11
Asphaltine Stability	16	Data Capture for Manual Testing.....	17
Automatic Transmission Fluid		Baths for Manual Testing.....	14
Brookfield Viscosity.....	56	Copper Corrosion by Petroleum Products	52
Copper Corrosion.....	21	Corrosion of Aviation Fuels - Silver Strip	53
Density.....	35	Corrosion of Lead by Lubricating Oils	54
Foaming Characteristics.....	28-32	Crankcase Oils Foaming Characteristics	28-32
Rust Preventing Characteristics.....	50,51	Corrosiveness and Oxidation Stability	
Automotive Gasolines		Aircraft Turbine Engine Lubricants.....	46
Anti-Rust Properties.....	50, 51	Light Oils.....	46
Copper Corrosion.....	52	Crude Oil	
Hydrocarbon Type.....	20	API Gravity, Density, Specific Gravity.....	35
Kinematic Viscosity.....	8, 9	Pour Point.....	12, 13
Octane Number.....	22-25	Data Acquisition	
Oxidation Stability.....	49	for Cetane Number Engine.....	26,27
Phase Separation.....	12, 13	for CFR Engine.....	22-27
Silver Corrosion.....	48, 53	for Cloud Point.....	17
Aviation Turbine Fuels		for Distillation.....	17
Copper Corrosion.....	52	for Flash Point.....	17
Freezing Point.....	10, 15	for Octane Number Engine.....	22-25
Kinematic Viscosity.....	8	for Pour Point.....	17
Oxidation Stability.....	49	Demulsability Characteristics	34
Silver Corrosion.....	53	Density of Petroleum Products	35
Ball Bearing Grease Torque at Low Temperature	33	Deterioration of Rubber	
Baths		by Liquids or by Heated Air.....	57
Brookfield Viscosity.....	4-7	Diesel Fuels	
Kinematic.....	8, 9	API Gravity.....	35
Oxidation Stability.....	42-44	Cetane Number.....	26
Beverage Bottle Test of Hydraulic Fluids	40	Cloud Point.....	10-13
Blender, Automated, for Octane & Cetane Reference Fuels	27	Cold Filter Plugging Point (CFPP).....	10, 14
Borderline Pumping Temperature, Chiller	39	Copper Corrosion.....	52
Brookfield, Low Temperature Viscosity by	4-7	Heat Stability.....	21
CCS of Engine Oils	38, 39	Kinematic Viscosity.....	8, 9
Cetane Number Engine Automation	26	Low Temperature Flow Test (LTFT).....	18-19
Cigre Bath	48	Pour Point.....	10-13
Cleveland Open Cup Flash		Rust Preventing Characteristics.....	50, 51
Data Capture for Manual Test.....	17		

ALPHABETICAL INDEX (con't)

Diffuser Stones Test for Foaming Test			
Automated Test Apparatus.....	31	Oxidation Stability.....	49
Manual Test Apparatus.....	31	Phase Separation.....	12, 13
Mott Diffuser.....	31	Gear Oils	
Norton Diffuser.....	31	Copper Corrosion	52
Recertification Service.....	31	Foaming Characteristics.....	28-32
Distillate Fuel Oil		Kinematic Viscosity.....	8, 9
Cloud Point.....	10-13	Low Temperature Brookfield Viscosity.....	4-7
Cold Filter Plugging Point (CFPP).....	10, 14	Oxidation Stability.....	42-44
Low Temperature Flow Test (LTFT).....	18, 19	Rust Preventing Characteristics.....	50, 51
Oxidation Characteristics.....	42-45	Gravity	35
Pour Point.....	10-13	Grease	
Distillation , Data Capture for.....	17	Dropping Point.....	37
Dropping Point of Lubricating Greases.....	37	Oil Separation Test.....	41
Dyed Silica Gel for FIA Test.....	20	Low Temperature Torque.....	33
Engine oils		Heated Tube Technology for Oxidation.....	42
API Gravity.....	35	High Temperature	
Cold Crank Simulator (CCS).....	38, 39	Distillate Fuel Stability.....	21
Density.....	35	Dropping Point of Grease Apparatus.....	37
Foaming Characteristics.....	28-32	Viscosity Baths.....	9
Kinematic Viscosity.....	8, 9	Oxidation.....	46
Mini Rotary Viscometer (MRV).....	39	Humidity Cabinet for Rusting	55
Pour Point.....	10-13	Hydrocarbon Types (FIA)	20
Pour Point Stability.....	36	Hydraulic Fluids	
Extreme Pressure Lubricants		Brookfield Viscosity.....	4-7
Oxidation Stability.....	42-44	Corrosiveness and Oxidation Stability.....	46
FIA (Fluorescent Indicator Absorption)	20	Filterability.....	40
Filterability of Hydraulic Fluids.....	40	Hydrolytic Stability.....	40
Flash Point Testers , Data Capture for.....	17	Low Temperature Viscosity.....	4-7
Flock Point	37	Hydrolytic Stability of Hydraulic Fluids	40
Fluorescent Indicator Absorption (FIA)	20	Impinger Method	41
Foaming Characteristics of Oils		Induction Period for Oxidation of Gasoline	49
Diffuser Stone Calibration.....	31	Inhibited Steam Turbine Oil Oxidation	42-45
High Temperature.....	28-30	In-Line Automated Analyzers	
Sequence I, II, III.....	28-30	Cetane.....	26
Washer for Foam Testing Tubes.....	32	Octane.....	25
Freezing Point Apparatus		Insulating Oils Oxidation Stability	49
Assembly for Manual Testing.....	15	Kinematic Viscosity	8, 9
Automated Apparatus for Jet Fuel.....	10, 11	Knock Characteristics of Fuels	22-25
Aviation Fuels.....	10, 15	Lead Corrosion of Lubricating Oils	54
Data Capture for Manual Test.....	17	Low Temperature	
Distillate Fuels.....	10, 15	Brookfield Viscosity.....	4-7
Gasoline		Characteristics of Aviation Fuel.....	10, 15
Knock Characteristics.....	22-25	Cloud Point - Manual Baths.....	12, 13
Octane Number.....	22-25	Cloud Point - Automated Apparatus.....	10, 11

ALPHABETICAL INDEX (con't)

Data Capture for Manual Tests.....	17	Permeability of Diffusers for Foam Testing	31
Freezing Point of Jet Fuels.....	10, 15	Phase Separation of Gasoline	12, 13
Kinematic Viscosity Baths.....	8, 9	Pour Point	
Pour Point - Manual Baths.....	12, 13	Automated Analyzers.....	10, 11
Pour Point - Automated Apparatus.....	10, 11	Data Capture for Manual Testing.....	17
Torque of Grease.....	33	Manual Testing Baths.....	12, 13
Low Temperature Torque of Grease	33	Stability of.....	36
Motor Fuels Knock Characteristics	22-25	Porosity of Diffusers for Foam Testing	31
Mott Diffuser	31	Pour Size of Diffusers for Foam Testing	31
Mini-Rotary Viscometer, Chiler for	39	Reference Cetane Fuels Automated Blender	27
Norton Diffuser	31	Reference Octane Fuels Automated Blender	27
Octance Reference Fuel Automated Blender	27	Refined Oils Corrosiveness and Oxidation Stability.....	46
Octance Number Lab Engine Automation	22-24	Reflection Meter	21
Octane Number On-Line Automation	25	Refrigerated Recirculating Baths, for CCS and MRV	39
Oil Separation from Lubricating Grease	41	Rubber	
Oils		Deterioration in Heated Air.....	57
ATF		Effects of Liquids on Properties.....	57
Brookfield Viscosity of.....	4-7	Rust Preventing Characteristics	50, 51
Foaming Characteristics of.....	28-32	Rust Protection by Metal Preservatives	55
Crankcase, Foaming Characteristics.....	28-32	Separability of Oil from Grease	41
Crude, Pour point.....	12, 13	Silica Gel	20
Engine, Foaming Characteristics.....	28, 32	Silver Corrosion by Gasoline	53
Gear, Brookfield Viscosity of.....	4-7	Silver Corrosion by Aviation Turbine Fuels	53
Hydraulic		Sludging Tendencies	42-45
Brookfield Viscosity of.....	4-7	Specific Gravity	35
Filterability of.....	40	Stability of Pour Point	36
Hydrolytic Stability of.....	40	Steam Turbine Oils	42-45
Mineral, Oxidation Stability of.....	42-45	Tag Closed Cup Tester	
Motor, Foaming Characteristics of.....	28-32	Data Capture for Manual Test.....	17
Transformer, Oxidation Stability of.....	49	Tarnish Test	52
Turbine, Oxidation Stability of.....	42-45	Thermal Stability	42, 57
On-Line Automated Analyzers CFR Engine.....	25	TOST	42-45
Oxidation Stability.....		Turbine Oils, Oxidation of	42-45
Extreme Pressure Lubricating Oils.....	42-44	Universal Oxidation Stability Bath	47
Distillate Fuel Oils.....	49	Viscosity	
Gasoline.....	49	Brookfield Cold Air Chambers.....	6
Induction Period Method.....	49	Brookfield Programmable Liquid Baths.....	4, 5
Inhibited Minerals Oils.....	42-45	Elevated Temperature Baths.....	9
Insulating Oils.....	49	Hydraulic Oils.....	4-7
Straight Mineral Oil (Cigre Bath).....	48	Jet Fuel.....	8
Turbine Oils.....	42-45	Kinematic.....	8, 9
Universal Oxidation Stability Bath.....	47	Low temperature Baths.....	8
		Programable Liquid Baths.....	4, 5
		Washer for Foam Test Tubes	32
		Water Separability of Petroleum Oils	34

SELECT PETROLEUM TESTING INSTRUMENTS



Model L6468-8

High Temperature Bath
for Distillate Fuel Stability by ASTM D6468

See page 21



Model 28-1

High Temperature Heated Tube Bath
for API Gravity by ASTM D287 and D1298

See page 35



Model 423

Rust Testing Humidity Cabinet
as per ASTM 1748

See page 55



Model FM19PC

Automated Tester for Permeability and Porosity
of Foam Test Diffusers as per ASTM D892 and D6082

See page 31



Model FM-20

Upgrading of Existing Twin Jar Foam Apparatus
as per ASTM D892 and D6082

See page 30



Model 406

Automated Washer of Foam Test Cylinders
as per ASTM D892 and D6082

See page 32



Model 377-4

Automated Apparatus for Hydraulic Fluids Filterability
as per IP 48, ISO 13357, NF E60-690 and NF E60-691

See page 40

SELECT PETROLEUM TESTING INSTRUMENTS



Model LB-76-2

Low Temperature Programmable Liquid Baths
for Brookfield Viscosity by ASTM D2983

See page 4

Air and Liquid Baths
for Foam Testing by ASTM D892 and D6082

See page 28



Model 323



Model 305

Water Oil Separability
as per ASTM D1401

See page 34

Automated Low Temperature Flow Apparatus (LTFT)
as per ASTM D4539

See page 18



Model 362



Model 295-6

Constant Temperature Liquid Bath for Silver Corrosion Testing by
ASTM D4814

See page 53

Automation for Octane Number CFR Engines
by ASTM D2699, D2700, and D2885

See page 22



Model AO-871



Model OC-23-V

Automated Blender for Octane and Cetane Reference Fuels
for CFR Engines as per ASTM D2699, D2700, and D613.

See page 27