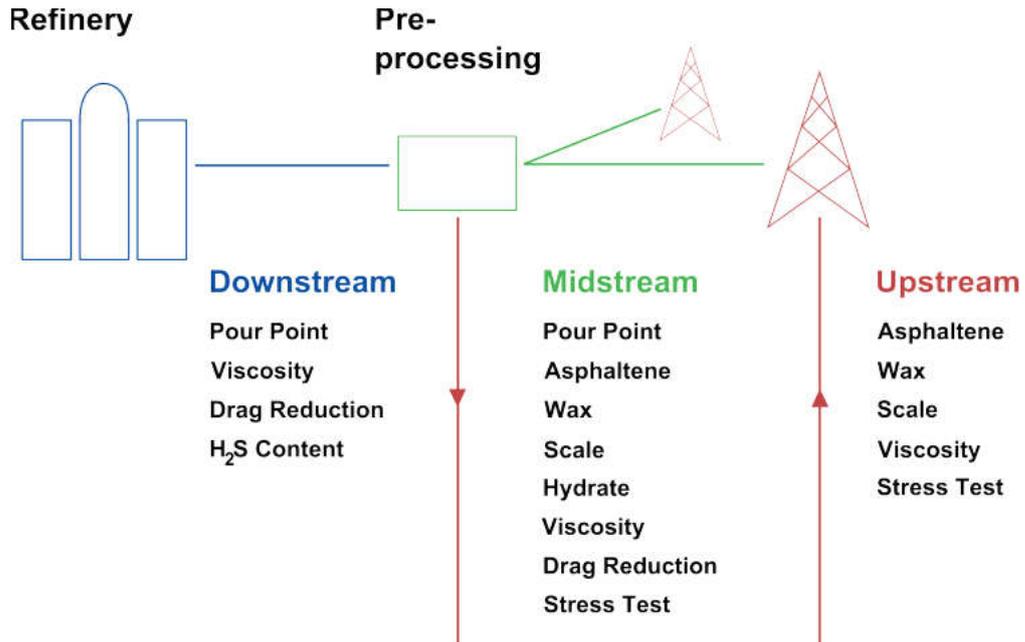




# Pleasure to measure!

lab instruments for oil and gas

# Fields of Application



Pour Point



Asphaltene



Wax



Scale



Hydrate

## References



# Pleasure to measure - Our mission and success!

## lab instruments for oil and gas

### We set new laboratory standards with our instruments

We have been developing, manufacturing and selling innovative laboratory instruments specifically for Flow Assurance for 25 years, setting new standards in the laboratory for professionals. We have been awarded innovation prizes for this. Our export quota of 90 % earned us the Export Oscar of Northern Germany.

PSL stands for reliability, quality and innovation. We are proud that the Big Five in the industry are among our satisfied customers.

#### WHAT IS YOUR BENEFIT?

### Reliable, high-quality instruments for your success



**SAVE TIME IN YOUR LABORATORY**  
with automated test cycles, cleaning procedures and easy-to-clean parts.



**EASY TO USE**  
with a user-friendly, high-quality design for simple, correct and safe handling.



**LONG LIFETIME MADE IN GERMANY**  
thanks to sophisticated and robust design as well as high-quality materials and manufacturing.



**TRUSTED SERVICE - WORLDWIDE**  
with our online support, maintenance contracts and on-site service. We guarantee 20 years of repair service.



**MEASURE LIKE INDUSTRY LEADERS**  
With innovative and advanced instruments you can measure future-proof like the leading laboratories.



**PLEASURE TO MEASURE**  
Our instruments make work a pleasure. They were developed together with the users.

**Learn more about our instruments**





# Modernize Pour Point Measurements

with the

## Pour Point Tester PPT 45150



### Characteristics

- Rotational method - ASTM D5985
- 30x more accurate than D 97
- Pour Point, No-Flow Point, WAT
- Very fast cooling/heating
- Pour Point up to +140 °C (284 °F) and down to -55 °C (-67 °F)
- Fully automated test procedure

### Fast and accurate

The Pour Point Tester PPT 45150 by PSL Systemtechnik is a lab device, which provides pour point measurements of oil and oil products according to ASTM D5985 - rotational method .

The test method permits pour point measurement with highest precision up to 0.1 °C at high repeatability. Without additional cryostat the PPT covers a temperature range of -45 to +140 °C (-49 to +284 °F).

### Low temperature down to -55 °C (-67 °F)

Our Pour Point Tester is extendable with a cooling-water pre-cooler for temperatures down to -55 °C (-67 °F), a cost-effective alternative to cryostats with the same capacity.

### Repeated measurements

Pour point measurements can be repeated up to nine times in succession. We recommend those repeated measurements to obtain statistically significant results and information about the sample's behaviour over time.

### Operational worldwide

Due to modern thermoelectric technology the PPT only needs tap water and a power supply. So the PPT is excellently suited for operations outside the lab. The Pour Point Tester is equipped with a wide range voltage input so it can be operated all over the world.

### Transportable with trolley case

Optionally, a trolley case is available to transport the compact and lightweight Pour Point Tester as carry-on baggage.

### Stand-alone device or use with PC

Of course, the PPT can also be used as a full-fledged lab instrument. Space-saving arranged, it can be operated as a stand-alone device or in conjunction with the software *WinPPT* via PC. With only few settings, you can start a fully automated test run.

Up to 10 test configurations can be saved on the instrument in stand-alone mode.



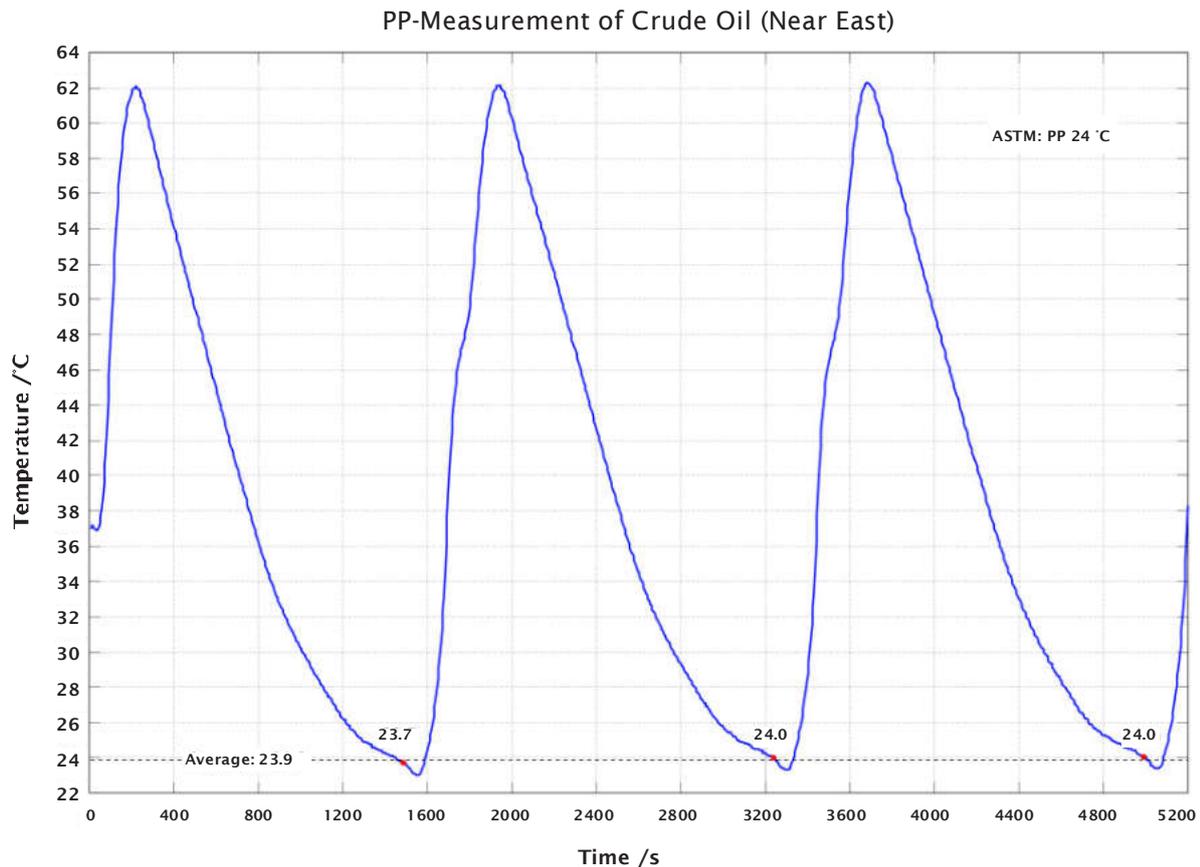
### An automated lab instrument

In combination with the PSL software *WinPPT* and a PC, you can execute fully automated test runs with the PPT. An unlimited number of test configurations can be saved and managed.

*WinPPT* permits comfortable control of test runs, data display and data saving in a

spreadsheet-compatible format for further evaluation.

The temperature gradient gives you additional information about the behaviour of the sample. First crystallisation processes are as well observable as strong exothermal reactions.



Measurement example for automatic repeated pour point measurement

### Specifications:

Standard:	ASTM D5985
Temperature range:	-45 ... +140 °C (-49 ... +284 °F) at tap water 8 °C (46 °F), down to -55 °C (-49 °F) with precooler
Resolution:	0.1 °C
Accuracy:	< ± 0.4 K (± 0.2 K typical)
Cooling water usage:	approx. 1-2 l/min
Cooling water pressure:	1 ... 6 bar (14.5 ... 87 psi)
Cooling water temperature:	+3 ... +25 °C (+37 ... +86 °F), down to -20 °C (-4 °F) with precooler
Power consumption:	1,700 W
Voltage input:	110 - 240 V~, 50/60 Hz - wide range
Weight:	9.5 kg, with trolley case 14 kg
Dimensions (WxDxH):	26 x 38 x 16 cm, height with sensor 43 cm

# Examine Asphaltene Precipitation

with the

## Flocculation Tester FT5



### Characteristics

- Test asphaltene stability
- Test wax and scale formation
- Measures in very dark, undiluted crudes accurate and reproducible
- For live oil up to 700 bar (10,000 psi)
- Temperature -20 .. +300 °C

The Flocculation Tester is a lab instrument, which enables fast and easy measurements to test either the efficiency of asphaltene inhibitors or the compatibility of condensates and asphaltic crudes.

It is particularly suited for samples with a very low translucency and can be used for measurements comparable with ASTM D6703 Automated Heithaus Titrimetry.

### Measure very dark, undiluted crudes

To measure the partial translucency of a sample and thereby determine flocculation points, PSL has developed a probe with a high light sensitivity of 0.005 lux. The light sensor can be automatically adjusted to the translucency of the sample. Thus, even measurements with very dark, undiluted crudes and oil products provide accurate and reproducible results.

### In-line measuring of asphaltenes, wax and scale up to 700 bar (10,000 psi)

For in-line solid detection PSL developed special probes - that can be screwed directly into a pipeline - for example: in the side stream or at shipping. The probes are available for three pressure ranges: up to 10 bar (145 psi), up to 200 bar (2,900 psi) and up to 700 bar (10,000 psi).

### Live oil testing - up to 700 bar (10,000 psi)

To measure live oils under pressure - for example simulating deepwater conditions the Flocculation Tester is available with a high-pressure vessel for up to 700 bar (10,000 psi) and an integrated stirrer.

### Stand-alone or fully automated

The Flocculation Tester FT5 is available as a stand-alone device as well as an automated



measuring station. The measuring station has an additional dosing pump for titrating the sample as well as a thermostat. The latter enables measurements at high temperatures to distinguish paraffin and asphaltene precipitation.

**Real-time charts with software**

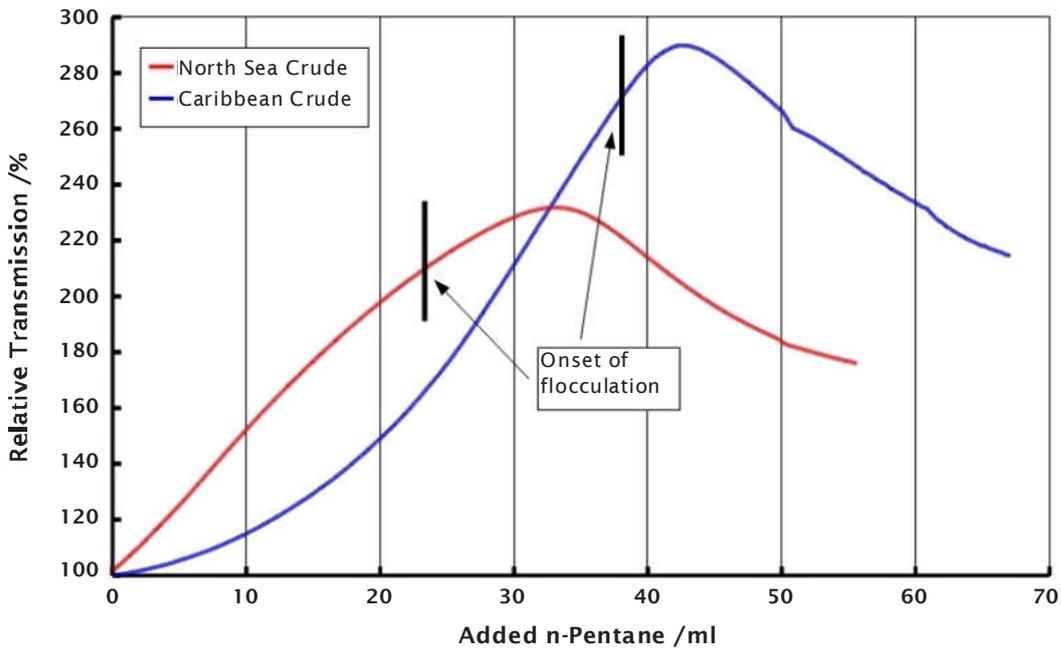
The Flocculation Tester System can be controlled via PSL's *WinFT* software. This software enables the easy scheduling and execution of experiments. Temperature and pressure gradients are displayed as real-time charts. The measuring results are displayed

in a user-friendly format and can be exported to spreadsheet programs for further data evaluation.

We provide three models of the Flocculation Tester FT5 for pressures up to 700 bar (10,000 psi) and temperatures from -25 to 200 °C (-13 to 392 °F).

In combination it is possible to measure pressures up to 650 bar (9,400 psi) at temperatures up to 150 °C (302 °F).

The Flocculation Tester can be adapted to your requirements.



Measurement example for asphaltene flocculation

**Specifications:**

Model:	Ambient Pressure	Mid Pressure	High Pressure	High Temperature
Pressure range:	No pressure / ambient	200 bar (2,900 psi)	700 bar (10,000 psi)	200 bar (2,900 psi)
Temperature range:	-10 .. +80 °C (14..176 °F)	-10 .. +120 °C (14..248°F)	-20 .. +180 °C (-4..356 °F)	RT .. +300 °C (RT..572 °F)
Stirrer speed:	For all models: 130 ... 1,000 rpm			
Titration speed:	0.01 .. 150 ml/min	0.001 .. 10 ml/min	0.001 .. 5 ml/min	0.001 .. 10 ml/min
Power consumption:	FT5: 300 W / thermostat, PC, pump: depending type			
Power supply:	FT5, PC: 110 - 240 V~ wide-range / thermostat: 230 V~ or 115 V~			
Weight:	FT5: 4 kg / other components depending type			
Dimensions (WxDxH):	FT5: 26 x 38 x 16 cm, Basic system: 110 x 50 x 40 cm (with PC)			

# Wax Content Testing

with the

## Multi-Place Cold Finger CF6

### Characteristics

- 6 measuring places for simultaneous tests
- Precise finger and bottle positioning for accurate results
- Removeable sleeves for easy weighing and cleaning
- 100 ml and 250 ml bottles can be used
- Stand-alone device or automated with software

The Cold Finger is a common used device for those who examine the wax deposition of crude oil and condensate.

The Cold Finger by PSL Systemtechnik improved the established test method in its operation and provides measurement recording by Software.

The Multi-Place Cold Finger is equipped with 6 measuring places for multi-place testing with 100 ml or 250 ml bottles. Combining multiple cold fingers in one heating bath facilitates screenings on wax inhibitors, e.g. simultaneous testing of different chemicals on a single sample or testing of different inhibitor concentrations with the same sample.





Separately removable during tests

ensure that all of the sample gets in touch with the cold finger surface. The amount of wax that deposits at this surface at given temperature in ratio to the total amount of sample is an indication of potential amount of wax deposition as well as, related to a blank test, for the efficiency of a wax inhibitor (WI).

### The Advantages

1. More accurate and reproducible results  
Thanks to temperature control and locking mechanism.
2. Higher measurement reliability  
Thanks to easily removeable Cold Finger sleeves.
3. More flexibility in the test set-up  
Thanks to different sample volumes
4. Easier to handle  
Thanks to lifting system and secured water bath

### Our Solution

Our focus was a simple operation, higher safety level and a faster measuring process compared to similar cold finger devices on the market. We are very proud of our successful result. The CF6 complements the Cold Finger product family with an entry-level model for small budgets, but with the typical PSL quality. Remove the cold finger caps separately and reattach them to monitor deposition vs. time effects.

### Measurement Principle

A crude oil sample is stirred and kept above Wax Appearance Temperature (WAT). A cooled zylinder element - so called 'cold finger' - is immersed in the sample, providing a cold surface where the waxes of the crude oil shall deposit. An integrated magnetic stirrer is providing a gentle circulation to

### The Software

By using the Cold Finger with a PC and the software *WinCFC* you can control the temperature via PC and directly save the measuring data of the balance. With the software you can set the required parameters, which are documented for a test run. You can record single measurements or several measurements in an interval and evaluate the recorded data later.

We adapt the Cold Finger to your requirements.

### The PSL Cold Finger Family

- Multi-Rack Cold Finger CF15
- Coaxial-Shear Cold Finger cCF6
- mobile Cold Finger mCF2

### Specifications:

Temperature range:	
Cold Finger (surface)	-5 .. +65 °C (+23 .. +149 °F)
Water bath (sample)	+30 .. +90 °C (+86 .. +194 °F)
Number of measuring places:	6
Sample volume:	approx. 80 ml or 220 ml per finger
Stirrer speed:	100 ... 2000 rpm
Weight:	95 kg (CF6) + 40 kg (each thermostat)
Voltage input:	230 V~ or 115 V~
Dimensions (WxDxH):	35 x 68 x 97 cm + PC, thermostat(s)

# Wax Content Testing

with the

## Multi-Rack Cold Finger CF15

### Characteristics

- Up to 15 measuring places for simultaneous tests
- Reproducible results and simple, user-friendly handling
- Small, reusable sample volume
- Precise sample temperature measurement
- Portable version mCF2 with two fingers available

The Cold Finger is well known for those who examine the wax deposition of crude oil and condensate.

The Cold Finger by PSL Systemtechnik improved the established test method in its operation and provides measurement recording by Software.

The Multi-Rack Cold Finger is equipped with up to 15 measuring places for multi-place testing in lab. Combining multiple cold fingers in one heating bath facilitates screenings on wax inhibitors, e.g. simultaneous testing of different chemicals on a single sample or testing of different inhibitor concentrations with the same sample.





Separately removable during tests

### Our Solution

Use the modern way to measure wax deposition with the Multi-Rack Cold Finger by PSL Systemtechnik. Up to 15 samples can be monitored simultaneously for quick screening and analysis.

Run your test with different temperatures in one test run. Remove the cold finger caps separately and reattach them to monitor deposition vs. time effects.

### The Simple Handling is Convincing

Three drawers with 5 measuring places each are set in a robust aluminium-frame.

The drawers can be easily pulled. Insert the filled sample beakers to the measuring places and lower the cold finger caps into the sample. Adjust the test conditions either directly at the instrument or via software and start the experiment.

After the test is finished you pull the drawer out again. Push the cold finger up to its holding bracket. You can just pull off the cold finger cap with the wax deposits. This is easy, as the knurl at the upper, dry rim of the cell is used as gripping surface. You can then weigh the cell and with the software you can save the weight of the wax deposit.

### Further Advantages

The cold finger caps are all calibrated with an accuracy of <0.01 g. So the caps can be changed between the measuring places and do not need to be weighed before a test to determine the tare weight.

The drawers with their integrated temperature control enable the removing of single samples during a test. Thus you can determine the time-behavior of deposits for one sample or start different tests separately.

The low sample amounts of max. 75 ml help to save test material.

Every drawer has its own temperature control, so samples can be tested simultaneously under different conditions.

With the high precision balance exact results can be provided with a relative measuring accuracy of 0.01 g.

### The Software

By using the Cold Finger with a PC and the software *WinCFC* you can control the temperature via PC and directly save the measuring data of the balance. With the software you can set the required parameters, which are documented for a test run. You can record single measurements or several measurements in an interval and evaluate the recorded data later.

We adapt the Multi-Rack Cold Finger CF15 to your requirements.

## Specifications:

Temperature range:	Standard range	Low temperature
Cold Finger (surface)	-5 .. +65 °C (+23 .. +149 °F)	-20 .. +65 °C (-4 .. +149 °F)
Dry bath (sample)	+30 .. +120 °C (+86 .. +248 °F)	-10 .. +80 °C (+14 .. +176 °F)
Number of measuring places:	5 (1 rack, basic), 10 (2 racks) or 15 (3 racks)	
Sample volume:	70 - 80 ml/finger	
Stirrer speed:	0 / 450 ... 1,200 rpm	
Power consumption:	1,450 W (CF) + 3,600 W (thermostat)	
Voltage input:	230 V~ or 115 V~	
Weight:	95 kg (CF) + 40 kg (each thermostat)	
Dimensions (WxDxH):	55 x 59 x 118 cm + PC, thermostat(s)	

# Wax Content Testing

with the

## mobile Cold Finger mCF2

### Characteristics

- Designed for mobile use or small required sample throughput
- 2 measuring places
- Small, reusable sample volume
- Highly precise measurements with weight-calibrated finger sleeves
- Software for documentation

The Cold Finger by PSL Systemtechnik improved significantly the established test method in its operation and provides measurement recording by software.

The mobile Cold Finger is equipped with two measuring places for testing in the lab and is designed for high mobility to be used in the field, in a mobile lab or at customer site.



### Measurement Principle

A crude oil sample is stirred and kept above Wax Appearance Temperature (WAT).

A cooled cylinder element - the 'cold finger' - is immersed in the sample, providing a cold surface where the waxes of the crude oil deposit. An integrated magnetic stirrer is providing a gentle circulation to ensure that

all of the sample gets in touch with the cold finger surface. The amount of wax that deposits at this surface at given temperature in ratio to the total amount of sample is an indication of potential amount of wax deposition as well as, related to a blank test, for the efficiency of a wax inhibitor (WI).



mobile Cold Finger mCF2 with thermostat



Left: finger inserted    Right: finger lifted

### High mobility

The reduction to two measurement places allows this specific design for a very mobile use with easy, quick changes of location. You don't need to bring the sample in the main lab, you can measure directly at the sampling site. This is optimal for quick sample checks in production or quality control. Also for low sample throughput the mCF2 is a perfect choice.

### Software

The mobile Cold Finger can be operated stand-alone or you can connect it to a PC or laptop. Then the sample temperature and thermostat for finger temperature are controlled via our WinCFC software. This saves the readings of the sensors and the finger weighings from the balance directly for documentation.

### High precision

Just like his bigger counterpart, the Cold Finger CF15 which has set a new industry standard, this mobile Cold Finger works with the same high precision. The finger is cooled very homogeneously allowing a reproducible deposition of the wax. The removable finger sleeves are weight-adjusted with a deviation of <0.01 g. The finger sleeves can be exchanged between different measurement places and they can be remounted to determine wax deposition rate or - in case of lack of sample - the wax can be melted to use the same sample for further tests runs.

## Specifications:

Temperature range:	
Cold Finger	-5 ... +65 °C (23 ... +149 °F)
Sample temperature	+30 ... +100 °C (+86 ... +212 °F)
Number of measuring places:	2 fingers
Sample volume:	70 - 80 ml
Finger rotation speed:	0 / 480 .. 1200 rpm
Weight:	9 kg
Voltage input:	230 V~
Dimensions (WxDxH):	25 x 55 x 54 cm (main unit)

# Wax Deposition under Shear Conditions

with the

## Coaxial-Shear Cold Finger cCF6

### Characteristics

- Constant shear at finger surface due to rotating finger
- Convincing improved handling
- 6 measuring places for simultaneous tests
- Highly precise measurements with weight-calibrated cold finger caps
- Software for documentation

### Cold Finger with Shear

Measure wax deposits under shear conditions in oils and other fluids with PSL Systemtechnik's automated Coaxial-Shear Cold Finger cCF6.

Wax deposition in production and transportation of crudes is one of the most common challenges in flow assurance. While traditionally solvent based, thermal or mechanical methods are used to remediate wax deposition, chemical treatment with wax inhibitors is increasingly deployed to mitigate deposition.

To qualify the effectivity of the wax inhibitors different methods are used. One of the most common is the Cold Finger test.





### Measurement Principle

A crude oil sample is stirred and kept above Wax Appearance Temperature (WAT). A cooled cylinder element - so called 'cold finger' - is immersed in the sample, providing a cold surface, where the waxes of the crude oil shall deposit. An integrated magnetic stirrer is providing a gentle circulation to ensure that all of the sample gets in touch with the cold finger surface. The amount of wax that deposits at this surface at given temperature in ratio to the total amount of sample is an indication of potential amount of wax deposition as well as, related to a blank test, for the efficiency of a wax inhibitor (WI).

Different than with a 'classical' Cold Finger, a constant shear can be applied to the finger surface by rotation of the finger. By use of different rotation speeds the shear condition that applies during production on the pipeline wall can be simulated.

### Test Procedure

The cCF6 is designed as a very compact instrument combining 6 fingers integrated in one drive block in the head section of the cCF6. The sample bottles are screwed in the block and immersed with a pneumatic lift into

a temperature controlled water bath. At the end of the experiment the head section is lifted again and the bottles are removed. To measure the amount of wax deposition the well-fitting measurement sleeves are removed from the fingers and then weighed on a balance.

### Great advantage

The sleeves are adjusted with a deviation of <0.01 g. Therefore fingers can be exchanged between different measurement places. Furthermore, the low weight of the finger sleeves provides best precision for measurement on the balance up to 0.01 g. Finally, the sleeves can be reinstalled to determine deposition rate or - in case of lack of sample - to use the same sample for further tests runs.

### Software

If you have connected the Cold Finger to a PC, you can control temperature via WinCFS software and save the readings of the balance directly, which are also documented immediately. In this way, the experiment data is automatically documented in your files.

The Coaxial-Shear Cold Finger can be adapted to your requirements.

### Specifications:

Temperature range:	
Cold Finger	-5 ... +65 °C (23 ... +149 °F)
Sample temperature	+30 ... +90 °C (+86 ... +194 °F)
Number of measuring places:	6 fingers
Sample volume:	max. 250 ml
Finger rotation speed:	0 .. 400 rpm
Power consumption:	3,000 W
Voltage input:	230 V~ or 115 V~
Weight:	100 kg
Dimensions (WxDxH):	55 x 59 x 118 cm + PC, thermostats

# Examine Wax Appearance and Deposition

with the

## Wax Flow Loop

### Characteristics

- Examine wax inhibitor and dissolver
- Shear dependent deposition testing
- Fully automated with real-time graphs
- Small sample volumes from 100 ml
- Pressurized testing option
- Exchangeable model pipeline
- Yield stress and pipeline restart tests

### Fully automated lab instrument

The Wax Flow Loop is a compact laboratory instrument that allows you to examine the effects of wax, paraffin and asphaltene precipitation and deposition in pipelines directly in your lab. The Wax Flow Loop provides fast, accurate and reliable results for research of inhibiting and dissolving agents or quality control. The Wax Flow Loop is fully automated with its integrated PC. Start a test run in the morning, get your results by midday and in the meantime get the current state of the measuring by real-time diagrams.



### Easy measuring

The sample is heated to a set start temperature and pumped through a cooled/heated model pipeline, while the differential pressure and differential or outlet temperature are measured. Pressure changes indicate wax depositions to the inner wall of the model pipeline and temperature changes indicate wax crystallisation in the medium itself.

### Real-time diagrams

The differential pressure and temperature are displayed as real-time diagrams on the monitor. This allows precise conclusions about development of wax depositions and crystallisation in the medium during a test run. To maximize deposition effects and to shorten test-times shock-cooling is possible.

### Small sample volumes

Only 100 ml of sample are sufficient to come to conclusions about the efficiency and effectiveness of wax inhibitors or dissolvers. As an additional feature, pipeline restart and yield stress tests can be executed.

### Exchangeable model pipeline

The model pipeline can easily be exchanged. Thus you can vary the length and diameter of the model pipeline for different measuring approaches. By changing the pump rate you can measure the deposition at different shear rates.

The instrument features different operation modes to execute automated test schedules with fixed configuration as well as flexibly arranged test conditions. For example short

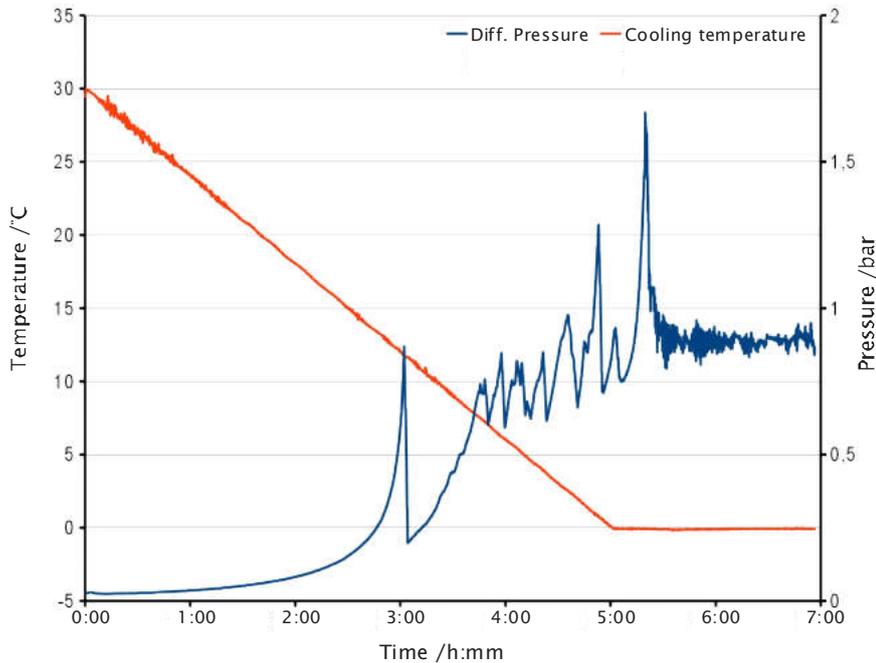
tests can be performed in open loop or long-term experiments in closed loop, on fixed temperature or temperature ramp. Direct injection at model pipeline is possible, too.

### Easy use and automatic cleaning

The integrated PC and the software allow an easy usage of the instrument.

The software supports the definition and management of standardized experiment runs. So repeated runs under similar conditions can be done in time-saving quick succession. To clean the model pipeline from remains of chemicals, it is possible to execute an automatic cleaning after every test run.

The Wax Flow Loop can be adapted to your requirements.



Measurement example for wax deposition

### Specifications:

	WL 508	WL 4012	WL 20012
Temperature range:	-20 .. 80 °C (-4 .. 176 °F)	-40 .. 120 °C (-40 .. 248 °F)	-25 .. 120 °C (-13 .. 248 °F)
Sample inlet:	25 .. 80 °C (77 .. 176 °F)	25 .. 120 °C (77 .. 248 °F)	25 .. 120 °C (77 .. 248 °F)
Pressure range:	0 .. 5 bar (0 .. 72 psi)	0 .. 40 bar (0 .. 580 psi)	0 .. 200 bar (0 .. 3,000 psi)
Flow rate:	0.1 .. 200 ml/min	0.1 .. 260 ml/min	0.1 .. 100 ml/min
Sample volume:	all models: min. 100 / 250 / 1,000 ml		
Stirrer speed:	all models: 100 ... 1,400 rpm		
Voltage input:	all models: 230 V / 50 Hz or 115 V / 60 Hz		
Dimensions (WxDxH):	130 x 60 x 70 cm	130 x 60 x 70 cm	140 x 60 x 70 cm

# Examine Wax Appearance Temperature

with the

## Optical WAT Detector OWD

### Characteristics

- Most accurate measurement of wax appearance temperature WAT
- Measurement by cross-polarized light (CPM principle)
- Ultra-high sensible light sensor
- Small sample volume of <1 ml
- Fast and precise temperature control
- Adaptable temperature ramps

### Measure Wax Appearance Temperature WAT with high precision

The precise detection of a samples wax appearance temperature WAT is of high importance for multiple applications.

The new Optical WAT Detector OWD allows a fast and accurate measurement for the onset of wax crystallization of oil samples with the integrated thermoelectric heating/cooling unit and a highly sensitive light sensor.

Besides the use in a laboratory the unit is also highly portable for field tests.



### Measurement principle

The Optical WAT Detector uses the principle of light cross-polarization and the property of hydrocarbon crystals to alter the direction of the oscillation angle of polarized light. The sample is placed in a small test chamber with less than 1 ml volume. The chamber has a transparent bottom including a polarized filter, it is illuminated from below so the

polarized light can pass the sample. On top is a second polarized filter which is set to an angle of 90° for maximum elimination. When cooling down wax crystals form in the sample and change the orientation of the polarized light so a higher amount of light can pass the second filter. This change of light transmittance is detected by the highly sensitive light sensor.

### Cloud point detection

The detector also allows to measure the cloud point for paraffinic content, e.g. for condensates, diesel and fuel oils.

### Low sample amount

The OWD runs with only a very small sample amount of less than 1 ml. Just a few drops placed on the sensor plate are enough to run an entire temperature profile for the determination of the sample's WAT or cloud point.

### Portability

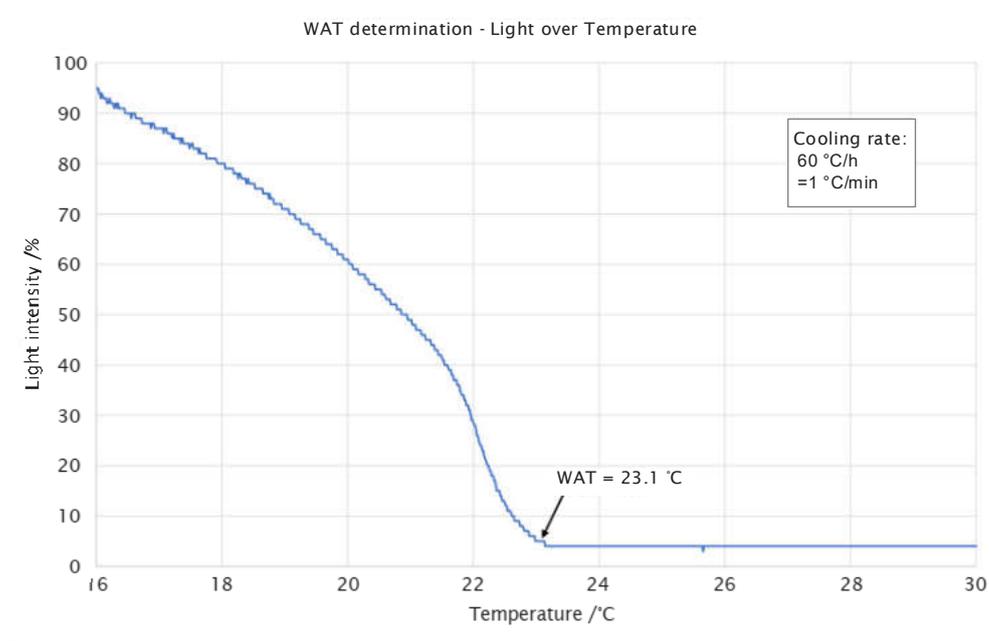
Designed for use in laboratories as well as a portable unit for field tests the OWD offers a high flexibility. Only a water supply or a

portable chiller is required for counter-cooling.

### Stand-alone or controlled via software

The OWD can be operated stand-alone with the integrated, fix programs. More comfortable and more flexible is the use of the WinOWD control software. With the software additional features are available, e.g. a more detailed customization of ramp settings, a time-saving sweep program, test repetitions. Also the data can be exported to a spreadsheet program.

The Optical WAT Detector can be adapted to your requirements.



Measurement example for wax appearance temperature (WAT) determination

## Specifications:

Temperature range:	-20 .. +80 °C (-4 .. +176 °F) with cooling water at +10 °C -30 .. +80 °C (-22 .. +176 °F) with pre-cooler at -5 °C
Sample volume:	< 1 ml
Accuracy / Repeatability:	0.1 °C / 0.2 °C
Power consumption:	max. 90 W
Voltage input:	110 - 240 V~, 50/60 Hz wide-range
Weight:	4.7 kg
Dimensions (WxDxH):	19 x 32 x 22 cm

# Examine Scale Deposition and Blocking

## with the Differential Dynamic Scale Loop

### Characteristics

- Tube system for scale deposition and blocking
- Fully automated with decreasing inhibitor concentrations
- Up to +250 / +300 °C (482 / 572 °F)  
up to 45 / 172 / 400 bar  
(700 / 2,500 / 5,800 psi)
- Overnight runs and repeated tests
- Automated scale detection and cleaning procedure
- Sour setup available

The Differential Dynamic Scale Loop DSL is a tube blocking system as fully automated laboratory device to examine the precipitation and deposition of scale and salt at simulated pipeline and water pipe conditions.

The DSL was particularly developed to observe the process of barium sulphate and calcium carbonate (scale) forming under realistic conditions and to design counteractive measures. This is carried out in three steps:

1. Determine the risk of scale deposition
2. Selection or development of an inhibitor
3. Test the efficiency of the inhibitor and determine the minimal necessary inhibitor concentration.



### Mode of operation

To execute this process three HPLC-pumps are used. Two solutions - anionic and cationic - are mixed with a third fluid which contains a known concentration of inhibitor.

The mixed solutions are pumped through a test pipeline. By increase of pressure - measuring of differential pressure - the start of scale deposition is indicated.

### Small sample volumes

A sample volume of just 500 ml is already sufficient for one measurement. To simulate different environment conditions, measure-

ments can be executed at temperatures up to 250 / 300 °C (482 / 572 °F) and pressures up to 45 / 172 / 400 bar (750 / 2,500 / 5,800 psi).

### Automated decreasing concentrations

The three pumps system makes automated measurements with decreasing inhibitor concentrations possible. The PSL software *WinDSL* permits scheduling and execution of complex test runs in steps with different inhibitor concentrations. The measuring data are visualised and stored in an ASCII-compatible format. An import of data to Excel

for easy evaluation is possible. Beside measuring data further information is saved in a log-file.

Also the configuration of a test schedule can be saved and reloaded separately.

### Automated cleaning procedure

With the software a fully automated cleaning after every test is preset, so in general you do not have to exchange the test pipeline. Two cleaning fluids provide a short preparation for next test run. The scale solvent quickly removes the scale deposition and distilled water rinses the tubings to get pH value back to 7 to prepare for next test run.

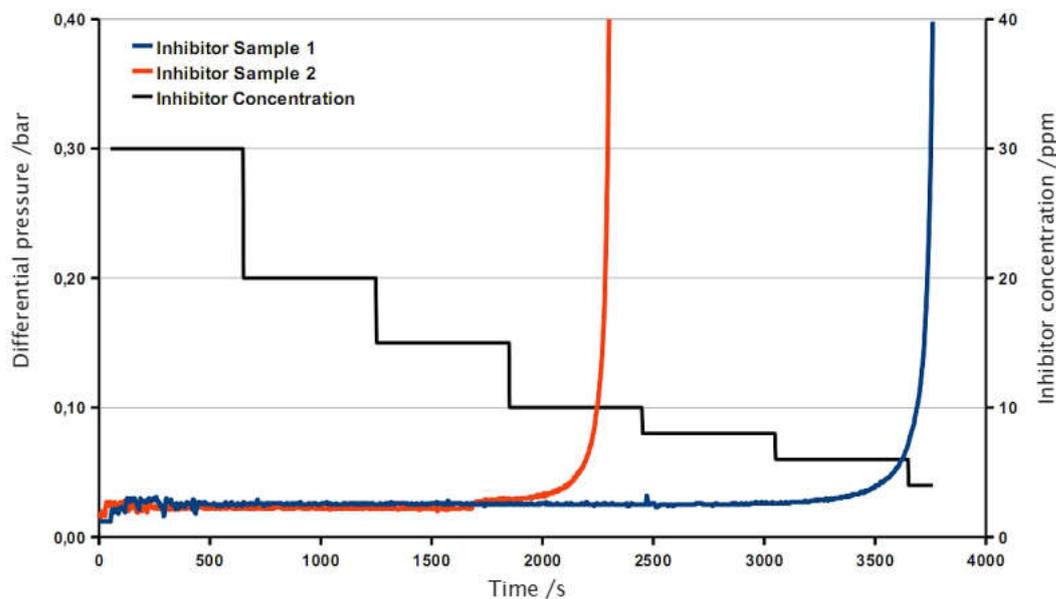
### Monel® for heated parts

A long lifespan and durability of the instrument is achieved by using Monel® for all parts exposed to heat except for the model pipeline. For sour water a model with Hastelloy® for all wetted parts is available.

### Exchangeable test pipeline

The test pipeline can be exchanged and is available with different length, inner diameters and materials to simulate different pipeline or water pipe conditions.

The Differential Dynamic Scale Loop can be adapted or extended to your requirements, e.g. for core flood testing.



Measurement example for test on critical inhibitor concentration

## Specifications:

Temperature range*:	+30 ... +250 or +300 °C (+ 86 ... 482 or 572 °F)
Working pressure range*:	3,4 bar ... 45 / 172 / 400 bar (50 psi ... 700 / 2,500 / 5,800 psi)
Flow rate*:	single pump: 0,1 .. 10 ml/min overall flow, max. 30 ml/min
Test pipeline:	length: 2 m, ID: 0.75 mm, material: stainless steel other materials (Cu, Al, Hastelloy,...), lengths and IDs on request
Power consumption:	max. 2,500 W
Voltage input:	230 V~ or 115 V~
Weight:	70 kg
Dimensions (WxDxH):	140 x 45 x 60 cm (without PC)

\* Alternative designs possible

# Examine Scale Deposition and Blocking

## with the mobile Differential Dynamic Scale Loop

### Characteristics

- Mobile tube blocking system for measurements in the field
- Semi automated
- Up to +150 / +250 °C (302 / 482 °F)  
up to 45 / 172 bar (700 / 2,500 psi)
- Live water extension
- Transport case

The mobile Differential Dynamic Scale Loop (mDSL) is a tube blocking system designed for scale deposition measurements inside and outside the laboratory.

The mDSL can be taken to customer site or into the field if the sample can't be transferred to your lab.

With our transport case the mDSL can be moved safely to its operation site.



### Mode of operation

The mDSL is a two-pump system. The standard test procedure uses artificial, separated brines with a fix inhibitor concentration and a manual switch between brines and cleaning solutions. Test of tube blocking tendency, inhibitor performance and dissolver effectiveness are the typical applications.

### Heating cartridge - test capillary

The mDSL has a specially designed heating system for the test capillary. Instead of a tube coil the capillary is in a pressure-tight cartridge system. This cartridge allows an easy opening of the coil, giving access to the precipitated scale particles. Also it makes the cleaning process more simple.

### Live water extension

For our instrument two extensions are available. Both allow the direct injection of real live water samples.

For **carbonate** scale forming waters with dissolved gas or particles the sample can be injected pressurized and is drained in a second pressurized waste container. The sample will not depressurize in the whole process.

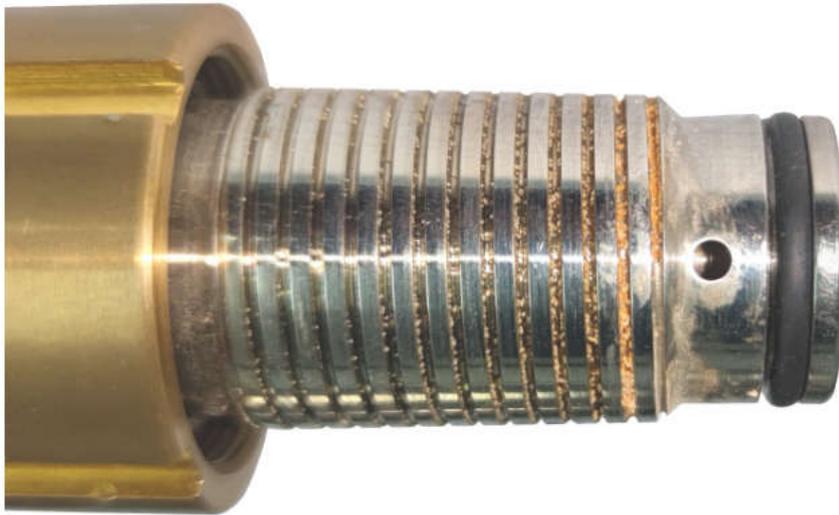
For sulfate scale forming waters the injection line is additionally heated and the test capillary can be cooled for testing the temperature dependence of the scaling process.

### Results from field tests as from the lab

Test conditions in regard to flow rates, temperature and pressure rating are comparable to the scale loops known from the labs. This allows you to obtain results in field tests that are comparable to those found in the laboratory.

### Software control

Our software *WinDSL* permits to control all parameters for the experiments, records all data and automatically stops the scaling test when scale formation is detected to ensure the capillary is not blocked.



Test capillary with precipitated scale

## Specifications:

Temperature range:	+30 ... +150 or +250 °C (+ 86 ... 302 or 482 °F)
Working pressure range:	3,4 bar ... 45 / 172 bar (50 psi ... 700 / 2,500 psi)
Flow rate:	single pump: 0,1 .. 5 ml/min overall flow, max. 10 ml/min
Test pipeline:	length: 1 m, ID: 0.75 mm, material: stainless steel
Filter:	integrated, mesh size 2 µm
Power consumption:	max. 2,500 W
Voltage input:	110 .. 230 V~, 50/60 Hz wide-range
Weight:	45 kg (60 kg in transport case)
Dimensions (WxDxH):	45 x 65 x 60 cm (main unit)

# Examine Gas Hydrate Formation

with the

## Gas Hydrate Autoclaves GHA 200 & 350



### Characteristics

- Tests gas hydrates and KHI
- Simulates pipeline conditions
- Testing up to 350 bar (5,000 psi)
- Captures photos and videos during test
- Up to 3 cameras simultaneously
- Torque measurement for AA testing
- Easy opening mechanism
- Sour gas compatible (optional)

### See what is going on!

The Gas Hydrate Autoclaves GHA 200 and GHA 350 provided by PSL Systemtechnik are the renewed and updated versions of the standard pressure vessels for examining gas hydrate formation processes.

In a pressure range up to 200 bar / 2,900 psi (GHA 200) or up to 350 bar / 5,000 psi (GHA 350) the effectiveness and efficiency of thermodynamic and kinetic hydrate inhibitors and anti-agglomerants can be analyzed.

The Gas Hydrate Autoclaves provide multiple features on a small footprint.

Up to 6 hydrate cells can be operated simultaneously via PC software. With boroscope cameras gas hydrate formation can be visually observed. The GHA 200 has one top view camera or alternatively an overhead stirrer, the GHA 350 offers three cameras (1 top view, 2 side views at different heights) and simultaneously the overhead stirrer.

Photos and videos can be taken during tests. For sour gas testing all autoclaves are available as Hastelloy® model including all wetted parts.



Gas Hydrate Autoclave GHA 200



GHA 350 with 3 cameras  
in compact trolley

### Long term experiments

With the PSL software *Hydrate* automated tests can be run. The optical control of tests and the measurement of temperature, pressure and torque provide versatile test schedules and possibilities to analyze different requirements.

Double seal sets prevent even smallest pressure losses through leakage and permit long term experiments up to 30 days and longer.

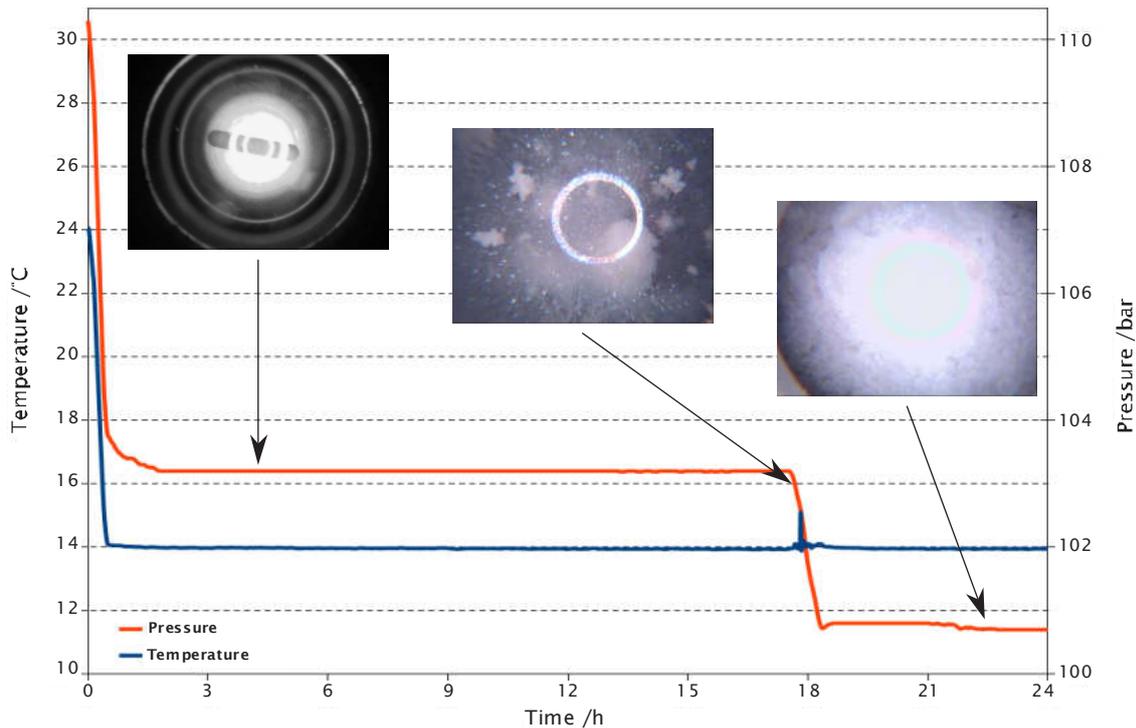
Due to an auto restart feature, the test results are save even in case of power failure.

### Highly ergonomic

Furthermore, the Gas Hydrate Autoclaves are highly ergonomic and requires small space on your laboratory desk.

The specially designed locking mechanism, to be opened by hand - no tools needed - and the integrated quick connectors make operation easy and comfortable.

The Gas Hydrate Autoclave can be adapted to your requirements.



Pressure decrease with kinetic gas hydrate inhibitor

### Specifications:

	GHA 200	GHA 350
Temperature range:	-10 ... +60 °C (+14 ... +140 °F)	
Accuracy / Reproducibility:	0.1 °C / 0.1 °C	
Pressure range:	up to 200 bar (2,900 psi)	up to 350 bar (5,000 psi)
Pressure accuracy:	0.5 %	
Cell volume:	450 ml total, 200 ml fluid (recommended)	
Optics:	Macro-boroscope, LED light source, fibre-optic	
Camera resolution:	1x 1280 x 1024 px, RGB32	3x 1280 x 1024 px, RGB32
Torque sensor:	instead of camera	additional to cameras
Measuring range:	0 - 1 Nm	
Accuracy / Resolution	0.1 % of total torque range	
Material:	Stainless steel (V4A), Viton®, Hastelloy® optional	
Power consumption:	max. 2,200 Watts	
Power supply:	230 V~ or 115 V~	
Weight:	40 kg (without PC)	45 kg (without PC)
Dimensions (WxDxH):	50 x 60 x 60 cm (without PC)	60 x 60 x 110 cm (without PC)

# Examine Gas Hydrate Formation

with the

## Rocking Cell RC5



### Strict method for research on inhibitors

With the Rocking Cell RC5 by PSL Systemtechnik hydrate formation can be examined in a lab instrument to test the effectiveness and efficiency of kinetic hydrate inhibitors and the influence of corrosion inhibitors. The Rocking Cell applies one of the most stringent test methods.

### Measuring principle

The measuring principle of the Rocking Cell is based on the tilting of cooled, pressurized test cells (rocking cells). While tilting, a ball inside the chamber is steadily rolling over the length of the test chamber, thereby blending the fluid-gas mixture. The movement of the ball creates strong shear forces and turbulences in the test chamber. Thus, the conditions in pipelines are reproduced.

### Test procedure

For testing, the test chambers are filled with a sample fluid (water or other) and a certain amount of inhibitor. The test chambers are cooled down to the test temperature. Subsequently, the central gas supply is used, to fill each chamber to the individually required pressure of up to 200 bar (2,900 psi).

### Well-engineered and user-friendly

The 5 test chambers are mounted on a movable axis in a closed cooling bath with cooling liquid. Only this axis is tilted during the test. The test chambers are magnetically

### Characteristics

- Screening tests of hydrate inhibitors
- Turbulent mixing and high shear forces
- 5 test chambers
- Pressure can be adjusted separately up to 200 bar (2,900 psi)
- Easy to handle, computer controlled
- Sour gas testing

attached and can thus be easily removed for filling or cleaning.

The compact Rocking Cell requires only a small amount of space .

### Typical experiment schedule

A typical experiment is executed in three steps:

1. Flowing conditions: The test chambers are see-sawed with an adjustable rocking rate and rocking angle. Meanwhile, they are brought to a given temperature, either directly or via temperature ramp.



2. Shut-in: The test chambers are kept in a given position (adjustable up to 45° angle). The sample is cooled or heated to scheduled temperature.

3. Restart flowing conditions: The test chambers are tilted again with an adjustable rocking rate and rocking angle and cooled or heated, respectively, to a given temperature. During a test run, temperature and pressure values are recorded.

Thus you can monitor hydrate formation by the pressure changes that result from forming and dissociation of gas hydrates.

### Variable test conditions with software

The pre-installed PSL software WinRC enables comfortable data recording and evaluation, as well as scheduling and execution of automated test runs.

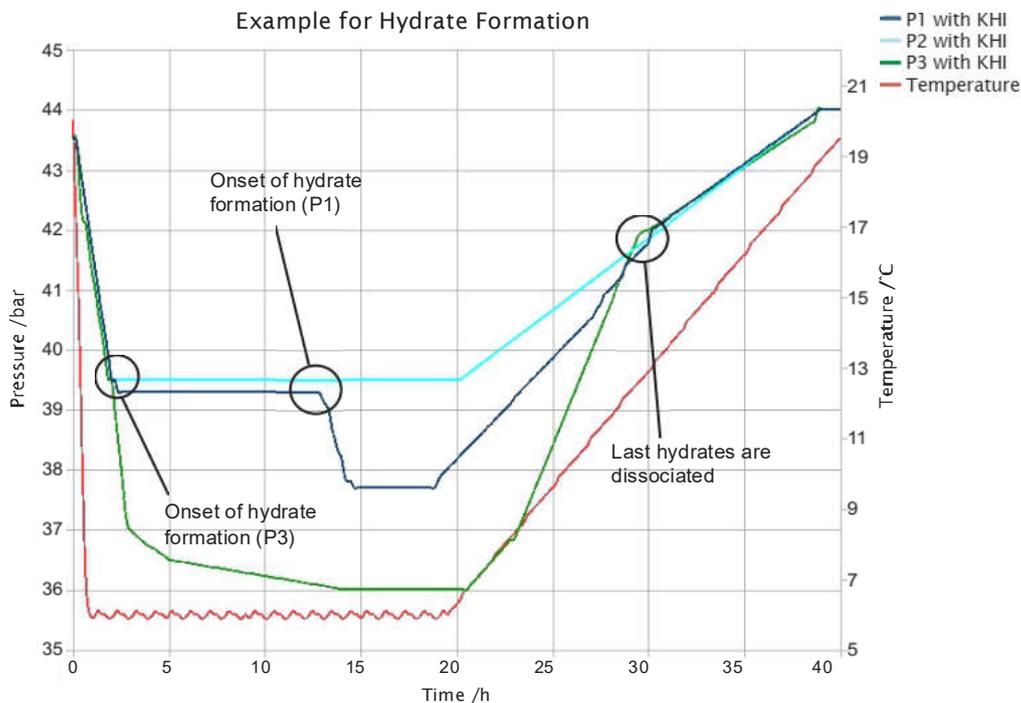
Versatile test runs are possible with variable

scheduling of test conditions. With the PSL software you can define test parameters like temperature, rocking rate and angle, duration of the test run and of shut-in, also position of the test chamber during shut-in. Long-time runs up to 30 days and longer are possible.

### Material of chambers and balls

Test chambers are made of stainless steel to achieve realistic pipeline conditions. For sweet gas testing V2A mixing balls can be used. For sour gas testing glass balls are available. Additionally, cells and manifold system can be made out of Hastelloy®. Feed lines and connections are made of PEEK, to prevent condensation.

Furthermore, we can adapt the Rocking Cell to your requirements.



## Specifications:

Test chambers:	5 Stainless steel (AISI 316 Ti) or Hastelloy*
Volume:	40 cm <sup>3</sup> (fluid + gas)
Rocking rate / angle:	1 .. 20 min <sup>-1</sup> / 1 .. 45°
Pressure range:	up to 200 bar (2,900 psi)
Temperature range:	-10 .. +60 °C (+14 .. +140 °F)
Data recording rate:	Variable, 1 to 30 sec
Bath volume, Cooling liquid:	9.5 litre, water-glycol-mix
Voltage input:	230 V~ or 115 V~
Power consumption:	90 W (RC5), 2,900 W (thermostat)
Weight:	21 kg (without thermostat)
Dimensions (WxDxH):	51 x 60 x 29 cm (without thermostat)

# Examine Gas Hydrate Formation

with the

## Sapphire Rocking Cell RCS



### Gas hydrate challenge

Oil and gas production in colder regions and in the subsea deepwater necessitates further development of Low-Dosage Hydrate Inhibitors (LDHI) as Kinetic Hydrate Inhibitors (KHI) and, particularly, Anti-Agglomerants (AA). For research on Anti-Agglomerants, the transportation of dispersed gas hydrate in the fluid flow of a pipeline must be ensured. Lab tests must prove the efficiency and reliability of inhibitors in field conditions. As a specialty of LDHIs, for approval of gas hydrate inhibitors a detailed statistical check of effectiveness is required. Thus, the objective is to conduct the necessary amount of tests in the least amount of time.

### Rocking cell measurement

The measuring principle of the lab instrument Sapphire Rocking Cell is based on the constant tilting (rocking) of temperature-controlled, pressurized test cells (rocking cells). Tilting the cell causes a ball to roll back and forth through the entire length of the test cell, mixing the enclosed fluid-gas mixture. This ball movement induces strong shear forces and turbulence inside the test cell, simulating pipeline conditions.

### Characteristics

- Test of AA and KHI at deepwater conditions
- Multi-phase flow testing
- Full view polished test cell for optimization of inhibitors
- Ball run-time measurement
- 4 designs - 2, 6, 8, 20 test cells max
- Stringent test conditions for improvement on product safety for deepwater application
- Sour gas testing

A typical experiment can be divided into three phases: flowing conditions, shut-in and restart flowing conditions.

Measuring the cell pressure and performing examinations for a drop in pressure provides information about hydrate formation.

By measuring the ball run-time, changes in intrinsic viscosity can be monitored.

### What PSL provides

The PSL Sapphire Rocking Cell conducts pressure, temperature and ball run-time measurements, all of which are visibly observable, and is specially designed for research on Anti-Agglomerants. Up to 20 cells can be used simultaneously, reducing test time with multiple measurements and providing statistical data within one test run.

The cells are pressure proof from 200 bar (2,900 psi) up to 350 bar (5,000 psi) and can be used separately at a constant volume or simultaneously at constant pressure. The temperature ranges from +60 °C (140 °F) to -10 °C (14 °F) respectively -20 °C (-4 °F). Thus a wide range of field conditions can be simulated, starting from cool temperature onshore transport up to deepwater applications.

With the ball run time measurement, the pumpability of the dispersed gas hydrate can be tested and referenced to intrinsic viscosity changes in the multiphase slurry.

The sapphire test cells are completely transparent. The entire sample chamber is visible for close observation of the sample behavior and the structure of the composed gas hydrates. In addition, the tests can be recorded by a video camera, making it possible to observe whether hydrates are gathering or compacting on less turbulent areas, i.e. the end of the cells. The interaction of LDHIs and other additional substances such as corrosion inhibitors (CI), asphaltene inhibitors (AI), wax inhibitors (WI) or scale inhibitors (SI) are accessible by experimental data. Free water or oil phases are detectable.

Upon request, the cell caps can be produced in high-grade stainless steel or Hastelloy® / Titanium to provide sour gas compatibility.

#### Your benefit

With the Sapphire Rocking Cell you will save considerable development and measuring time, e.g. over 75 % in comparison to a five

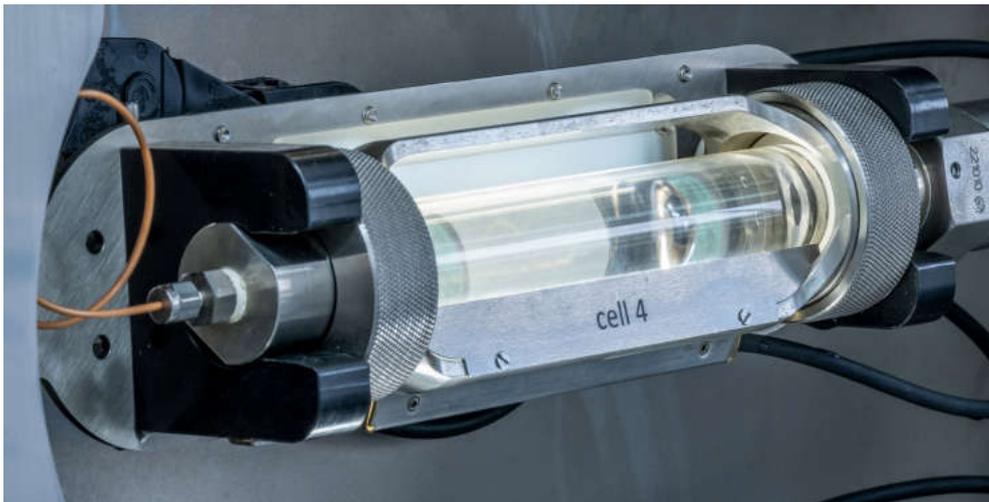
cell batch autoclave testing. Your project costs are also reduced accordingly.

Testing of Anti-Agglomerants with the Sapphire Rocking Cell will deliver useful statistical results. The cell meets the stringent conditions for evaluating inhibitors for deep-water applications. Anti-Agglomerants can be optimized and adjusted to your application and actual operating conditions, which allows a significant increase in product safety. The view into the test cell provides more information on how your inhibitor is working or why it failed.

#### Designed to your requirements

The Sapphire Rocking Cell is available in four designs. The Rocking Cell RCS2 with up to two test cells or the RCS6 with up to six test cells are models for small spacing, e.g. to be placed in a fume hood. The Rocking Cell RCS8 and RCS20 are stand-alone rig installations with up to 8 or 20 test cells.

We can also adapt the Sapphire Rocking Cell to your specific requirements.



Detail: Mounted and lighted sapphire test cell in cooling liquid

### Specifications:

Test cell:	RCS2 / RCS6 / RCS8 / RCS20: up to 2 / 6 / 8 / 20 sapphire glass cells
Volume:	20 cm <sup>3</sup> (fluid + gas)
Rocking rate / angle:	1 ... 20 min <sup>-1</sup> / 1 ... 45°
Pressure range:	up to 200 bar (2,900 psi)
Temperature range:	-10 ... +60 °C (+14 ... +140 °F), depending on thermostat
Data recording:	variable between 1 and 30 sec
Voltage input:	115 V~, 230 V~, 400 V~ 50/60 Hz
Power consumption:	max. 7 kW (without thermostat)
Weight:	RCS6 / RCS20: approx. 230 kg / 380 kg without thermostat
Dimensions (WxDxH):	RCS6 / RCS20: 110 x 36 x 90 cm / 200 x 80 x 220 cm without thermostat

# Test Viscosity of Extreme Conditions

with the

## HPHT-Viscometer

### Characteristics

- Temperature up to +200 °C (392 °F)
- Pressure up to 1,500 bar (27,750 psi)
- Small sample amounts
- For low, medium and high viscosities (5 - 100,000 mPas)
- Easy handling with pneumatic lifting platform
- For umbilical line restart tests, yield point and gel strength measurement, stability tests of emulsions

### Extreme conditions can be simulated

The High-Pressure High-Temperature Viscometer (HPHT-Viscometer) is a rotational viscometer. This type of viscometer can measure the viscosity of shear rate independent (Newtonian) fluids as well as the viscosity of shear rate dependent (non-Newtonian) fluids. The HPHT covers a wide range of pressures up to 1,500 bar (27,750 psi) and temperatures up to 200 °C (392 °F).



### Deep sea conditions

The HPHT's wide pressure and temperature range allows the simulation of extreme conditions prevailing for example with deep sea deposits. Thus, precise and reliable conclusions can be made for all fluids with a shear rate dependent viscosity e.g. crudes or drilling fluids.

### Application range

The rotational method is one of the few methods of viscosity measurement applicable not only to non-Newtonian fluids, but also to Newtonian fluids. Non-Newtonian fluids change their viscosity depending on the shear rate. The viscosity range covers values from approx. 5 mPa\*s (cP) up to 100,000 mPa\*s, depending on used geometry.

### Pneumatic lift for easy handling

The High-Pressure High-Temperature Viscometer consists of a mounting frame with pressure vessel, pneumatic lifting platform and uses the reliable Haake Viscotester as measuring instrument. With its dimensions of 45 x 50 cm the HPHT requires only a small footprint. For temperature control of the pressure vessel a thermostat is provided.

A PC with pre-installed control and data acquisition software RheoWin® can be provided for comfortable experiment configuration and execution.

### Additional measuring sensors

The Haake® Viscotester provides fast, easy and reliable measurements of fluids and pastes. The results - viscosity, shear stress and shear rate as well as e.g. yield point and operating temperature - are digitally displayed and can be read-out by software.

The absolute viscosity of a sample can be measured with appropriate geometries.

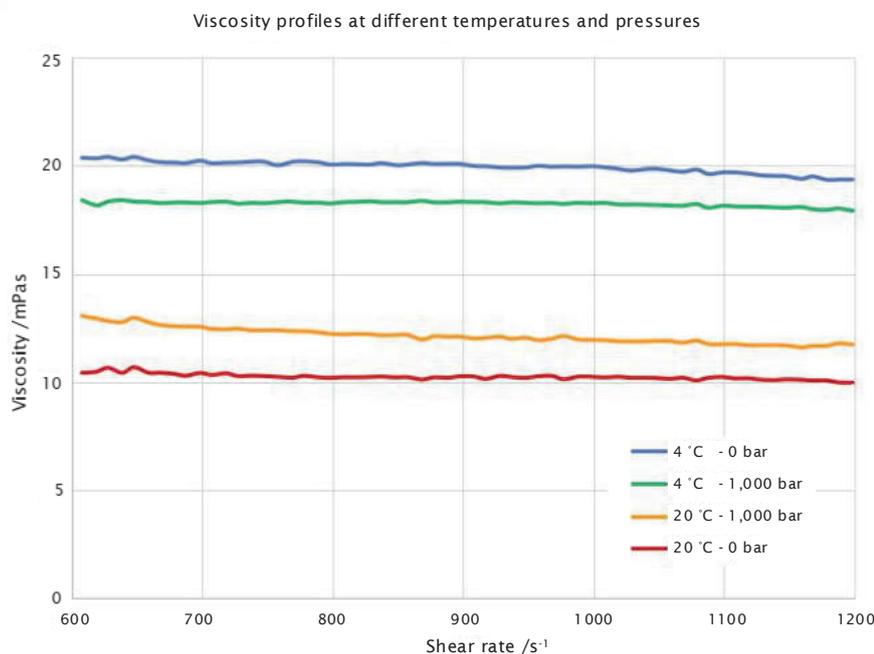
Additional measuring sensors are available. With the vane sensor you can not only execute yield point measurements, but also umbilical line restart tests, gel strength measurements and stability tests of emulsions. Thus the Haake® Viscotester can be adapted to various applications.

### Realtime charts with software

More challenging tasks, e.g. the automatic measuring of flow behavior of non-newtonian substances can be directly executed with pre-defined routines. Via PC, experiment runs can be freely programmed, controlled on-line and be evaluated.

### Variable test conditions

For viscosity measuring the Haake® Viscotester provides different factory set or adjustable rotational speed steps. The torque measuring with a non-contact, low displacement sensor increases the measurement precision, signal linearity and measuring range.



Viscosity evaluation with shear rate sweep at different pressures and temperatures

### Specifications:

Application:	High pressure and high temperature viscosity for Newtonian and non-Newtonian fluids
Standard:	DIN 53019 / ISO 3219, DIN 54453 with according geometries
Temperature range:	-20 ... +200 °C (-4 ... +392 °F)
Viscosity range:	5 ... 100,000 mPas (extended range possible)
Accuracy:	0.1 °C / ± 0.1 K
Rotational speed:	0.5 ... 800 rpm
Pressure range:	up to 1,500 bar (27,750 psi)
Power consumption:	1.900 W
Voltage input:	110 .. 240 V~, 50/60 Hz wide range
Weight:	60 kg, without PC and thermostat
Dimensions (WxDxH):	Viscometer: 45 x 45 x 140 cm

# Measure H<sub>2</sub>S in Bitumen or Heavy Fuel Oils

with the

## H<sub>2</sub>S Analyzer 320

### Characteristics

- For bitumen, asphalt, heavy fuel oils, crude and other refinery products
- Measures H<sub>2</sub>S, SO<sub>2</sub> in liquid and vapor phase
- Measures dissolved and evolving H<sub>2</sub>S
- Temperature range +30 ... +200 °C
- Gas tight sampling and storage cartridges
- Portable test unit - can be used on-site

### Present Situation

The test methods for bitumen, asphalt and heavy fuel oils used up to date are in general not giving reliable data, take a long time or are very expensive. Thus providing only insufficient solutions for requirements of most laboratories. The inadequate reliability of these test methods implies a big risk for health, safety and environment. The need for reliable test methods has increased over the past years. The reduce of limits for H<sub>2</sub>S content in bitumen and heavy oils strengthened this development additionally. To meet this increased demand Clariant developed a new method to measure H<sub>2</sub>S especially in bitumen. PSL moves the patented method into an instrument.

### New method - Enhanced Possibilities

The H<sub>2</sub>S Analyzer 320 measures dissolved and evolving H<sub>2</sub>S and SO<sub>2</sub> in bitumen and asphalt, a wide range of crude oils and refinery products under temperatures of up to +200 °C. The instrument provides very accurate and reliable results within the whole measuring range. The H<sub>2</sub>S Analyzer 320 works for a wide range of emission levels from 0.1 to 10,000 ppm H<sub>2</sub>S for the liquid phase and up to 1,000 ppm in vapor phase.

### Your Benefit

With the H<sub>2</sub>S Analyzer 320 you reduce scavenger treatment costs. You save development and measuring time compared to the actually used test methods. Your project costs reduce accordingly.

Testing of blending and with scavenger treated samples will get you much more accurate results over the measurement range. It fulfills the needed stringent conditions for a quick check on heavy fuel oils, bitumen, asphalt for specific plant and storage conditions. Scavenger treatment can be optimized, adjusted to your application and actual operating conditions allowing a significant increase in product safety.



## Measuring Principle

The measuring principle of H<sub>2</sub>S Analyzer 320 is based on DyMS method. The instrument is equipped with a multi-functional sampling, storage and preparation cartridge where the sample will be mixed permanently and held on temperature up to +200 °C. The sample is pumped into the measurement cartridge - loaded with a high boiling point solvent - and mixed continuously. Afterwards the H<sub>2</sub>S is stripped off by purging nitrogen through the liquid.

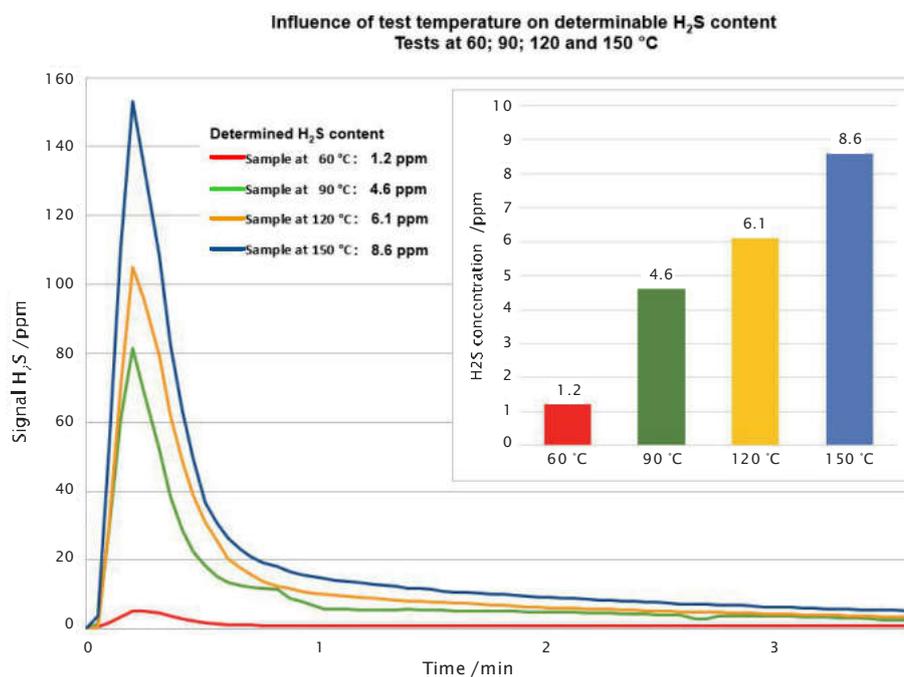
The use of inert gas nitrogen avoids oxidation of true H<sub>2</sub>S. The H<sub>2</sub>S concentration is finally detected by an electrochemical sensor.

In general a measurement requires 15 to 30 minutes. The results will be recorded, calculated and stored.

Further sulphur compounds like SO<sub>2</sub> may be measured simultaneously when respective sensors have been installed.

The set-up of H<sub>2</sub>S Analyzer 320 further allows the preparation of a second test sample while the first is still running. This feature increases the test flexibility and frequency.

By high temperature testing the risk of secondary H<sub>2</sub>S - forming out of other sulphur components at high temperatures - can be analyzed.



## Specifications:

Media:	Bitumen, asphalt, crudes, heavy fuel oil and other refinery products
Temperature range:	+30 .. +200 °C (+86 .. +392 °F)
Tested sample condition:	Liquid and vapor phase
Measuring range:	0.1 .. 10,000 ppm in liquid phase / 1 .. 1,000 ppm in vapor phase
Detected emissions:	H <sub>2</sub> S - other gases available on request
Pressure range:	up to 6 bar (87 psi)
Carrier gas:	Nitrogen N <sub>2</sub> (Inert gas)
Typical test duration:	15 to 30 minutes
Sample amount each test:	1 to 60 ml (typical 5 - 10 ml)
Sample storage container:	Two containers, 160 ml each
Sample viscosity range:	1 .. 3,000 mm <sup>2</sup> /s
Voltage input:	230 V~ or 115 V~
Weight:	35 kg
Dimensions (WxDxH):	36 x 43 x 21 cm, height with tubing: 50 cm

# Test Foam Stability and Foamer Efficiency

with the  
**Foam Tester FOA**

## Characteristics

- Run pressurized foam tests to simulate high temperature field conditions
- Test foam stability
- Test foamer efficiency in carry-over tests with continuous weighing
- Test defoamers in collapse tests
- Single or double tube setup with individual flow setting
- Based on ASTM D892

## Examination of foam generation under varying conditions

The Foam Tester enables an investigation of the generation and stability of foams. Inside a column, foam is generated by sparkling nitrogen or pressurized air through the liquid sample. The gas flow is injected by a sparger disc at the bottom to provide homogeneous bubbles. The sparger disc is made of a porous borosilicate filter material, different pore sizes are available. The gas is preheated before it is injected.

## Measuring aqueous solutions over 100 °C without boiling

- Pressure up to 10 bar (174 psi)
- Temperature up to 150 °C (302 °F)
- Flow rate up to 20 l/min



## Everything under control

The gas flow rate is controlled via software by an electronic flow controller. The pressure is controlled by a backpressure overflow

valve and shown on an analog pressure gauge and in the software. The temperature is maintained and controlled via software in a special designed dry bath heating oven.

## Different test modes

### Carry-over test:

Depending on temperature, flow rate, pressure and pore size of the sparger disc a foam is continuously produced. The foam is carried out through an overflow tube. Optionally, the overflow tube can be upgraded with active cooling.

The weight of the discharged foam is continuously measured using a computer-controlled balance. All data is recorded continuously.

### Foam collapse test:

The time for decomposition of the produced foam is evaluated by optical examination.

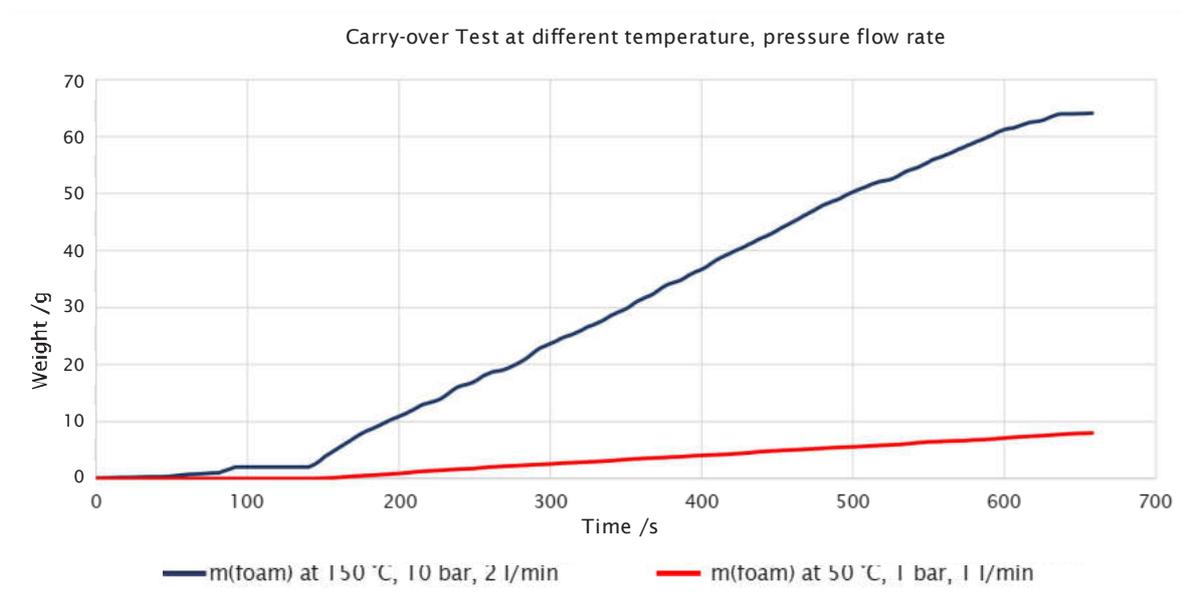
Depending on temperature, flow rate, pressure and pore size of the sparger disc a specific amount of foam is produced. Additives can be added before or during the

experiment manually. The gas supply is switched off and the speed of foam decomposition is determined by measuring the decreasing height of the foam over time.

### Foam stability test:

The height of the produced foam is evaluated by optical examination.

Depending on temperature, flow rate, pressure and pore size of the sparger disc a specific amount of foam is produced. Additives can be added before or during the experiment manually. After a certain time the foam reaches an equilibrium of newly produced and decomposing foam. The height of the foam can be read off a scale on the test cell.



## Specifications:

Temperature range:	Ambient .. +150 °C (+302 °F)
Pressure range:	Ambient .. 10 bar (145 psi)
Amount of test cells:	1 (Basic unit) or 2 (Extended unit)
Sample amount:	50 .. 200 ml (each cell)
Gas flow:	0.1 .. 20 l/min (adjustable)
Gas supply:	Pressurized air or nitrogen / max 12 bar (174 psi)
Power consumption:	max. 3,000 W
Voltage input:	230 V~
Weight:	Main unit: 68 kg / complete with one test cell : 97 kg
Dimensions (WxDxH):	44 x 54 x 143 cm + PC, balance(s)

# Stress Test of Oilfield Chemicals

with the

## Dynamic Stability Loop DySL



### Long term stability testing

The Dynamic Stability Loop (DySL) is designed to test oilfield chemicals for their long-term stability under the most stringent conditions. The DySL combines thermal stress testing of chemicals and pressurized conditions in a multi-loop system with up to four parallel loops.

### Measurement principle

The sample is circulated in a closed loop for a longer period and in this process. It is permanently subjected to thermal stress in a hot and a cold measurement section. Each section consists of a shorter preheating capillary, a long measurement capillary and a filter unit. Over the measurement capillary and the filter, the differential pressure is measured and observed over time as indicator for changes in physical properties due to instability of the sample.

With a backpressure valve the line pressure can be adjusted in a range of up to 344 bar (5,000 psi) to simulate your application's conditions.

### Viscosity changes

If the tested chemical is not stable it can decompose, this change in its composition causes a change of the sample's viscosity. The high precision sensors allow to detect even small changes in viscosity over time.

### Characteristics

- Test long term stability of oilfield chemicals
- Up to 4 loops for parallel testing
- Hot and cold bath for thermal stress
- Open and closed loop testing
- Small sample amount
- All loops independant

### Filter blocking tests

Decomposition and recombination or other reactions can cause a formation of particles, which can then accumulate in the filter, causing an increase in differential pressure over this filter. Different filter mesh sizes allow to adapt the test setup to your task.

### Deposition

Particles and other components can also form depositions on the capillary wall, these reduce the diameter, this process can be detected by an increase of the differential pressure.

### Absolute or differential pressure sensors

You can choose between to different types of sensors for each loop:

With the absolute pressure sensors the dead volume and required sample volume is minimized. Filling and cleaning afterwards are kept simple. The sensors are very durable yet allow a high precision in measuring the differential pressure over each section.

With the differential pressure sensors you get the highest possible precision in measuring the pressure drop over each section. The handling is more complex and more sample amount is required, but due to the exact measurement the DySL can additionally be used as pressurized capillary viscometer with this setup.

## Multi-loop testing

The Dynamic Stability Loop can be equipped with up to four parallel loops, each loop can be configured individually according to your requirements. Later upgrades are possible.

## Reservoir

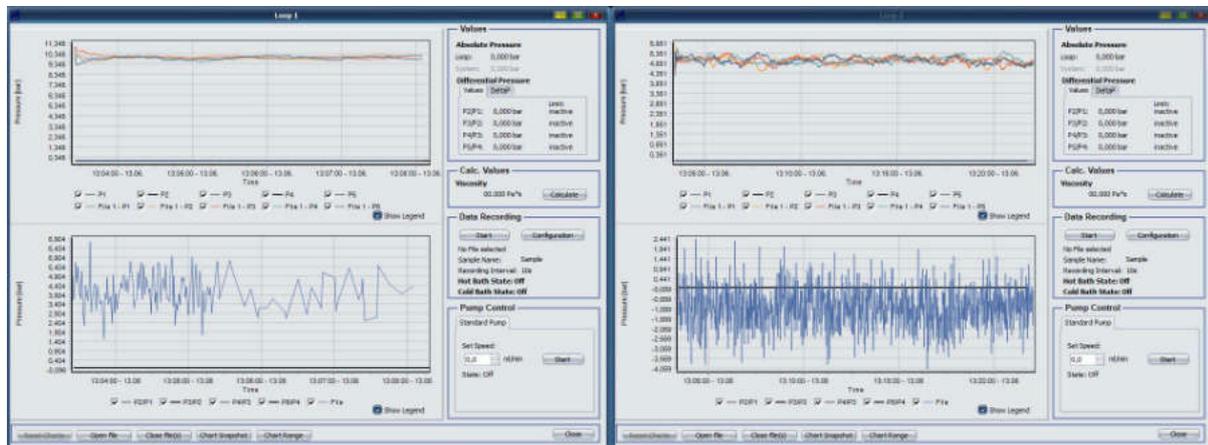
Each loop has its sample reservoir, you can choose between an ambient pressure reservoir or a pressurized container.

With the ambient pressure reservoir, the sample is subjected to maximum pressure stress due to complete depressurization in with every cycle. The handling and cleaning process is very easy.

The container keeps the sample at pressurized conditions during the complete test run. This allows to test also with outgassing components or with emulsions which require an elevated pressure all the time.

## Software control

Our software WinDySL allows a comfortable control of the instrument and a simple data acquisition. Each line can be handled individually with e.g. different flow rates and setups.



At a glance - Realtime display for each loop (pressure and differential pressure chart)

## Specifications:

Application:	Long-term stability test for oilfield chemicals, Filter blocking test Stress-test for umbilical line chemicals, Emulsion stability tests
Temperature range:	Cold bath: -10 .. +90 °C (14 .. 194 °F) Hot bath: +30 .. +150 °C (86 .. 302 °F)
Pressure range:	Loop: 344 bar (5,000 psi) / Reservoir: Ambient or 300 bar (4,350 psi)
Number of test loops:	Up to 4 loops
Flow range:	0.1 .. 10 ml/min (each loop set individually)
Power supply:	230 V~ or 115 V~
Weight:	250 kg (main unit with one loop)
Dimensions (WxDxH):	120 x 90 x 120 cm + PC
Other requirements:	Pressurized air supply (4 .. 10 bar)

# Quality Control of Drag Reducing Agents

with the

## Friction Flow Loop

### Characteristics

- Tests DRA efficiency
- Compact laboratory size
- Different Reynolds numbers can be analyzed within one test
- Minimized shear forces, no edges, constant acceleration
- Different line sizes usable

### Timesaving research on DRA

The Friction Flow Loop provided by PSL Systemtechnik is a fully automated Turbulence Rheometer in laboratory size for analysis of fluid behavior in pipelines.

Applications of the device are research on efficiency and optimization of drag reducing agents (DRA).

The instrument offers a time saving operation of the necessary tests in a compact design. An integrated PC and associated software allow an easy handling, monitoring and data logging of experiment runs.



### Mode of operation

The principle of the Friction Flow Loop is a huge hydraulic driven injection system. A hydraulic piston is driving a sample piston. Thus, any contact of hydraulic oil and sample can be eliminated.

The sample is pumped through a test line with small diameter. This way, experiments can be executed with a variable flow rate and a wide range of Reynolds numbers.

### Small sample volumes

Only a small volume of 3 litres and a test duration of 90 seconds are needed to run Reynolds number ramps of 6,000 to 80,000. This saves approximate one month compared to other test methods.

### Controlled measurements

By measurement of the absolute pressure or calculation of the differential pressure loss

for each line segment the drag effect can be monitored.

By comparison of the pressure losses with and without DRA the efficiency of the agents can be calculated easily. Using a flow rate ramp, different Reynolds numbers can be analyzed within one test. Repetitive tests enable check on long-term stability of the DRAs.

#### Without any sharp edges

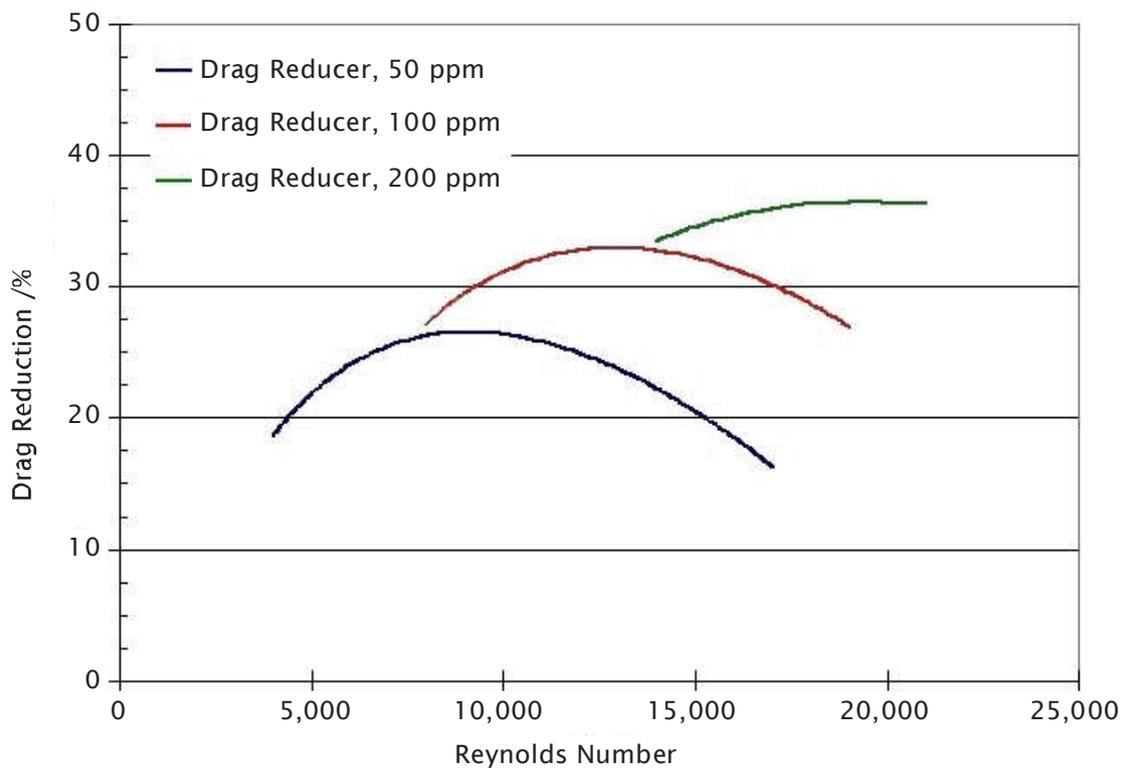
To ensure best measurement results, the Friction Flow Loop is specially designed without any sharp edges or diameter changes. The special shape of sample piston and

cylinder head assures constant acceleration at the line inlet to minimize shear forces.

#### Pneumatic pressure

Charging and discharging steps are done by pneumatic pressure. Thus, no pumps are necessary. Test line, specimen cylinder and sample vessel are double-jacket temperature controlled. Different line sizes can be used depending on sample viscosity.

The Friction Flow Loop can be adapted to your requirements.



Comparison of drag reducer efficiency for different concentrations

### Specifications:

Reynolds number:	80,000 (with 5mm line, water)
Temperature range:	-10 °C ... +80 °C (+14 °F ... +176 °F)
Pressure range:	0 ... 35 bar (0 ... 507.6 psi)
Line diameter / length:	3 mm, 5 mm/ 3.5 m
Sample volume:	0.5 l ... 3 l
Pneumatic input:	6 bar (87 psi), 1 l/min
Power consumption:	max. 6,000 W
Voltage input:	380 V~ / 16 A
Weight:	250 kg
Dimensions (WxDxH):	180 x 80 x 175 cm

# Services in our lab



## Third-party contract measurements for oil and gas

We offer contract measurements for Flow Assurance, crude and live oil, petroleum and petroleum products, gas hydrates and physical properties:

Asphaltenes:	Testing of asphaltene stability, inhibitor effectiveness Heithaus parameter at pressurized conditions (ASTM D6703, D7060, D711)
Gas Hydrates:	Testing of Anti-Agglomerants, Kinetic Inhibitors, Thermodynamic Inhibitors, determination of HET Rocking cell and autoclave testing
Scale Deposition / Inhibitors:	Testing of Scale Inhibitors and Scale Dissolvers Minimum inhibitor concentration (MIC)
Drag Reducer / Flow Improver:	Testing of Drag Reducing Agents (DRA) / Flow Improvers High range of Reynolds numbers
Long Term Stability:	Thermal stress test for chemicals and umbilical fluids Filter blocking tendency, viscosity change over time, long-time tests at pressurized conditions
Pour Point / No Flow Point:	Testing of Pour Point Depressants (PPD) ASTM D5985 - rotational method with No-Flow Point and Pour Point
Wax Deposition / WAT:	Testing of Wax Inhibitors, Wax Dissolvers, Viscosity Improver Determination of wax deposition tendency, screening Loop testing or cold finger
Viscosity:	Absolute dynamic viscosity, shear rate / shear stress / temperature depending with rotational viscometer Kinematic viscosity with falling ball viscometer
Thermal Conductivity:	Testing of thermal conductivity value Lambda, specific heat capacity, thermal diffusivity for fluids, gels and pastes ASTM D7896

**For your notes**

# Service laboratory

- Independent 3rd party testing
- We don't just build the instruments, we apply them
- Custom test setups - special solutions for special tasks
- Consulting



H<sub>2</sub>S Content



Stress Test



Viscosity



Drag Reduction



Wax

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