

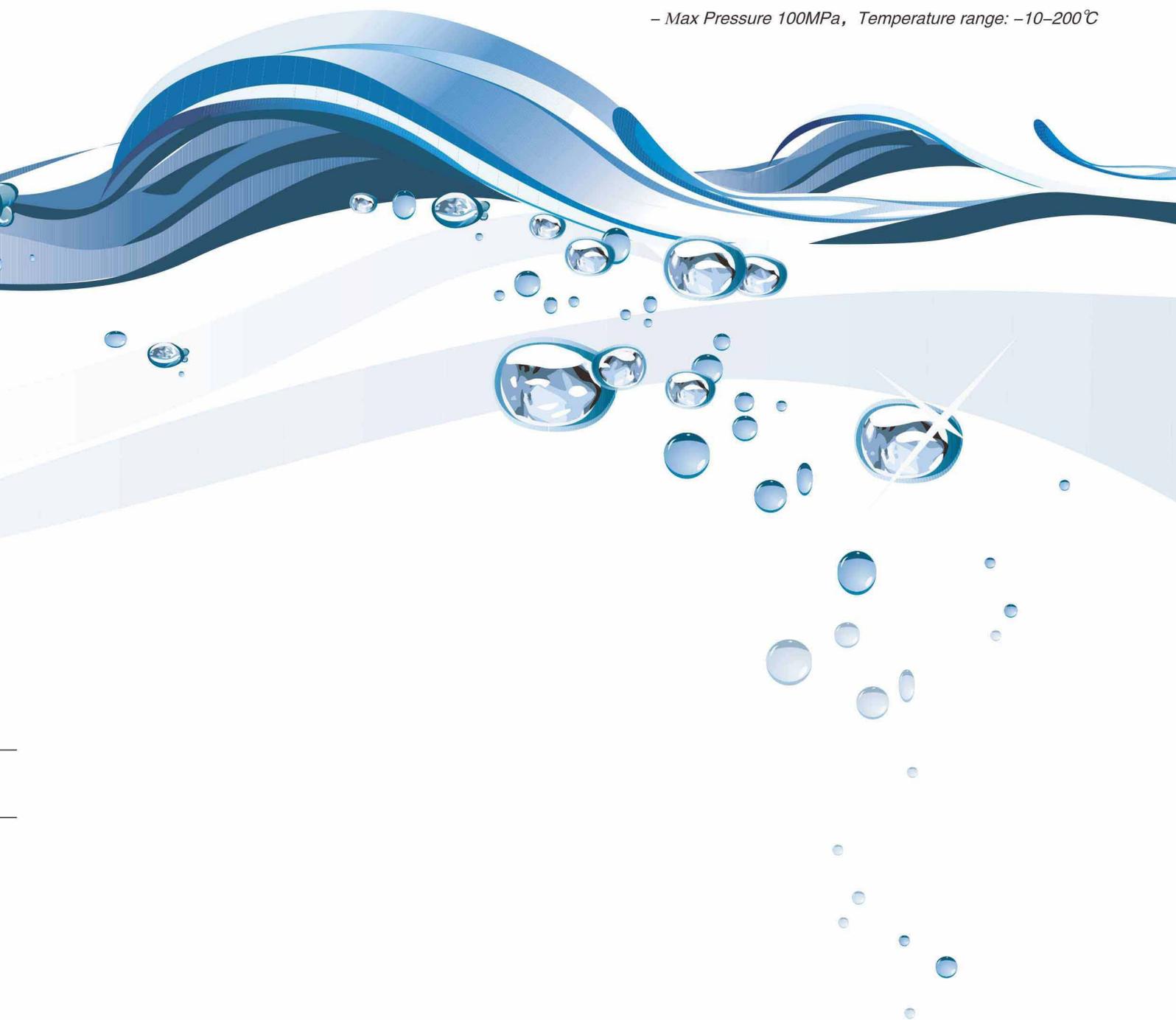
Kino

▶ **TX500™**

**Ultra High Pressure & Temperature
Spinning Drop Interfacial Tensiometer**

Model: TX500HP

– Max Pressure 100MPa, Temperature range: –10–200°C



TX500™

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Patent No.: CN201520706367.5, 201420747779.9, CN200920213959.8, CN200920213958.3



Ultra high pressure and temperature spinning drop interfacial tensiometer model TX500HP is special designed for measurement of interface tension (IFT) between liquid-gas/liquid-fluid system under high pressure and high temperature. Max pressure can be reached to 100MPa (Special design) and temperature range is between –10–200°C. IFT measurement via pressure and temperature is very useful for such applications as Enhanced Oil Recovery (tertiary oil recover). TX500HP can be used to measure IFT between ASP or binary liquid mixture systems and crude oil in the simulated condition with high pressure and temperature with min value about 10^{-7} mN/m. And beyond that, it can be used to measure IFT of your system with compressed liquid gas such as CO₂ or natural gas with extra connector port for gas system.

Applications

- IFT measurement of liquid-gas, liquid-fluid or liquid-fluid and liquid gas via pressure and temperature
- Development of ASP, binary liquid mixture systems or carbon-dioxide flooding in oil field
- Measuring surface tension or interface tension under high pressure and setup temperature by spinning drop method (max pressure: 70Mpa and max temperature: 180°C)
- Development of surfactant

If you want a normal pressure and temperature spinning drop interface tensiometer, please choose model TX500C or TX500K

$$\sigma_{SV} = \sigma_{SL} + \sigma_{LV} \cdot \cos \theta$$

$$\left\{ \frac{1}{R_1}, \frac{1}{R_2} \right\} = \sigma \cdot \left\{ \frac{\sin \phi}{X} + \frac{1}{R_1} \right\}$$

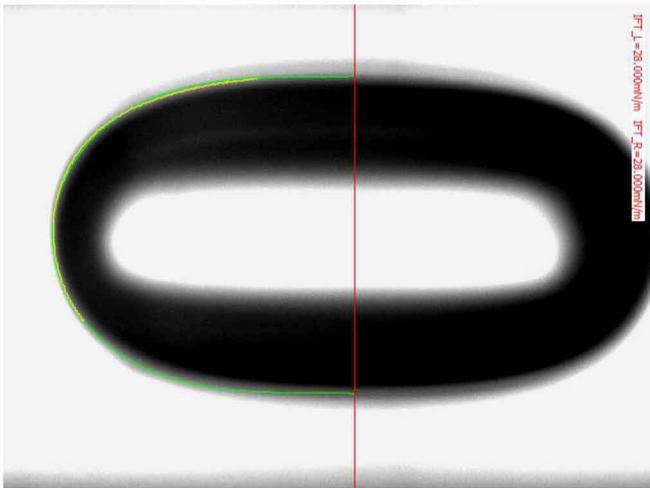
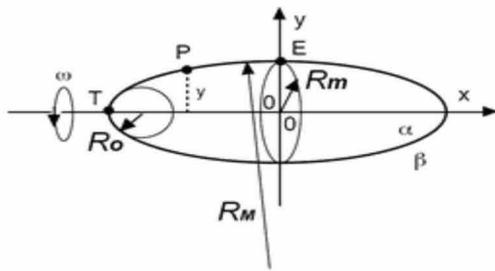
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Spinning Drop Method Used For Ultra-low Interfacial Tension Measurement:

Under conditions of constant temperature and constant pressure, interface energy increases as interface area increases. The increment of interface energy per unit area is referred to as interface tension, which is formed for the different attractive forces of molecules on both sides of interface to molecules on the interface. Spinning drop interfacial tensiometer can accurately analyze low / ultra-low interface tension, while normal methods such as Wilhelmy plate method and Du Nouy ring method are incapable of measuring such low values.

In general, interface tension of 10^{-2} – 10^{-1} mN/m is referred to as low interface tension, and that of below 10^{-3} mN/m as ultra-low interface tension.

To measure ultra-low interface tension, the original balance between gravity and interface tension should be artificially altered to enable the shape of balanced droplet can be easily measured. Making system rotate to increase action of centrifugal force field is the measurement principle of spinning drop method. As shown below:



Images of Captured Spinning Drop

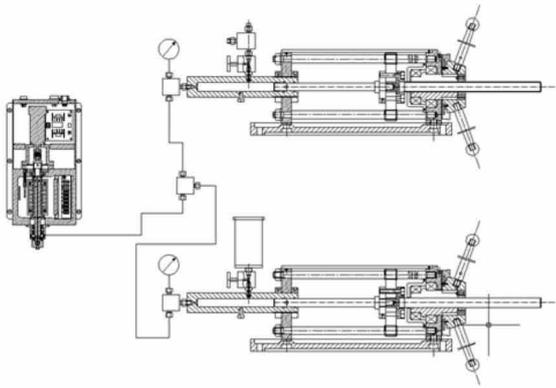
Generally, IFT will be decreased when pressure and temperature is increased such as interface tension between Air/water or kerosene/water, as shown below. But for IFT between oil and surfactant, it's more complicated. Each surfactant has its own working condition such as pressure or temperature, especially for crude oil and surfactant system, as shown below. You can find out the shape (ID of drop and shape of drop is changed into a ball) of the spinning drop is obviously changed when adding more pressure. So, we need to know how surfactant works under high pressure and temperature condition.



$$\sigma \cdot \left\{ \frac{1}{R_1} + \frac{1}{R_2} \right\} = \sigma \cdot \left\{ \frac{\sin \phi}{X} + \frac{1}{R_1} \right\}$$

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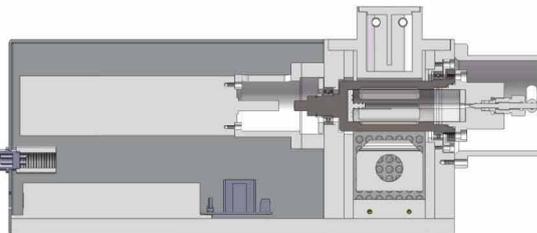
Schematic Draw of TX500HP



Performance Feature

1. Leading technology at ultra-high pressure and temperature spinning drop chamber – easy operation and safer

- various spinning drop chamber with different pressure for choice to meet your special need (10M Pa, 30M Pa, 50M Pa, 70M Pa or customization)
- Build in heating system with max temperature 180°C or more (Accepting custom-made)
- Removable sample tube system: Replaceable sample tube and easier to clean sample tube and sealing part to avoid cross pollution
- Mechanical sealing system and high speed spindle made of Ti to promise dependable sealing and lower locked-rotor torque
- Provide extra connector port for inert gas, nature gas or CO₂



2. Special made Mechanics System –professional and easy to operate

- Mechanics of three-axis precision positioning stages for lens control provide you clearer imaging and more accurate imaging position
- Lens tilt control and level control of chamber facilitate determining baseline between melt and solid and easy to get a vertical needle.
- Tilted unit for adjusting vision angle of parallel background light to promise a good drop shape.

$$\sigma_{SV} = \sigma_{SL} + \sigma_{LV} \cdot \cos \theta$$

$$\left\{ \frac{1}{R_s}, \frac{1}{R_c} \right\} = \left\{ \frac{\sin \phi}{X} + \frac{1}{R_s} \right\}$$

3. professional vision system – Clearer and higher speed

- Advanced drop shape profile lens and parallel background light ensures sharper imaging and clearer drop image edge;
- Continuous zoom industrial lens with magnification of 0.35 – 4.5X provides larger VOA, suitable for samples of varies volumes
- Lens with long working distance (180mm) effectively protect vision system from high temperature
- World highest speed camera (1280*1024) from Germany can reach 100FPS (WVGA)–400FPS (GIF)
- Calibrating ball made of Rubis or wolfram steel guarantees high precision



4. World leading analysis software CAST[®] 4.0

- Calculating interface tension automatically which is useful for measurement of dynamic interface tension:

You can measure interface tension (IFT) via time by just press one button “measurement” to start capturing drop image, calculating IFT, saving captured images and calculated result without any manual intervention. IFT via rotating speed, temperature, pressure and time will saved and managed by CAST4 and it can be exported into an Excel file.

- Calculating average IFT based on drop profile instead of two points at drop edge to acquire high precision result.

- Humanized software design and database management to promise:

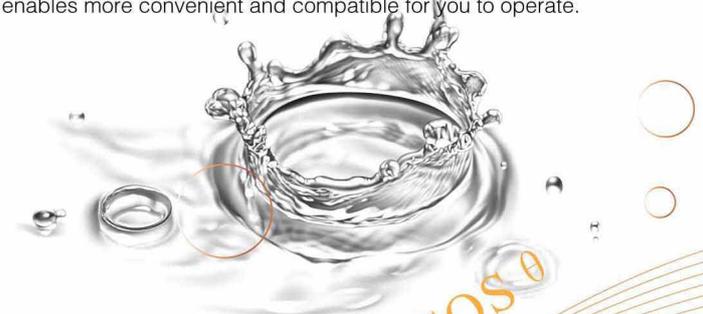
(1) Wizard design of standard windows is designed for various measurement operators.

(2) Database management: one-to-one correspondence between measured value and image; query and modifying of historical data at anytime

(2) Measured data is Excel exportable for you to create your measurement report conveniently.

(3) Secondary modification of eigenvalue. The software will record all your operation traces for you to check measured data, effectively avoiding errors caused by human.

(5) Comfortable language interface designed by Unicode enables more convenient and compatible for you to operate.



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Technical Specifications

Calculating interface tension based on Young–Laplace equation fitting method by captured spinning drop images under high pressure and temperature condition

Model TX500HP

Appearance



1.Specification of chamber	Provides chamber with 10MPa, 30MPa, 50MPa, 70MPa for option
Max pressure	0–30MPa or 70MPa (Depends on the system you chosen)
Max speed of motor	0 – 10,000 (RPM)
Control system of motor	Servo System from Switzerland
Heating system	Build-in heating system with max temperature: 180°C as standard (Optional system includes: max 200°C or Peltier thermostatic system (0°C) or thermostatic water bath system (– 10–200°C))
Max temperature	180°C or special designed (short-time operation at 200°C)
ID of sample tube	4mm or 2.5mm (Using tube with ID 2.5mm while pressure is higher than 30MPa)
Material of sample tube	sapphire glass (Above 20MPa) or explosion-proof glass SN6 (Below 20MPa)
Sealing method of sample tube	1、 Both ends open, mechanical seal, replaceable tube (Lower than 30MPa) 2、 Bilateral observation window installed on the spindle (Higher than 30MPa)
Material of high speed spindle	Tc4
Sampling method of crude oil	Extra dosing hole for sampling crude oil
Method for reading pressure	Digital pressure sensor with resolution 0.01MPa, accuracy 0.25%FS, max 80MPa and interface RS485
Method for reading temperature	Reading temperature of liquid at tube directly by PT100
Resolution of temperature	0.1°C
Sealing method of spindle	Non dynamic sealing method
Extra ports	exhaust port and connector port for gas
2.High pressure screw piston pump	For liquid-gas or liquid/fluid system or for liquid-fluid-liquid gas system
Control method	Manual (Automatically pump for option)
Max pressure	80MPa
Exhaust port	Provided with a drain port at the bottom of the chamber
Max volume of container	100mL
Value and tube	Made of stainless steel for high pressure system / Hastelloy C276 for option

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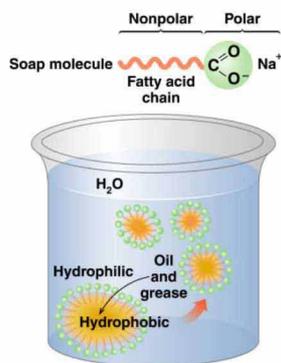
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3. General Specifications and Specifications for software

Range of IFT	10^{-7} – 100mN/m
Range of readable width	0–4mm depending on ID of tube
Accuracy of reading	0.001mm
Measuring method	Vonnegut method, Bashford-Adams
Calculating method	Pressing one button “measurement” to start capturing drop image, calculating IFT, saving captured images and calculated result without any manual intervention
Report management	One-to-one correspondence between measured value and image; query and modifying of historical data at any time.
Modification of eigenvalue	The software will record all operation traces for you to check measured data
Result exporting	All measured result and captured images can be exported.
Live windows	Live video and captured images
Function controlled by software	Speed and position of camera
Real-time curve	IFT via time

4. Dimension and Weight

Dimension of Main body	100 (L) * 70 (W) * 40 (H) cm
Weight of Main body	45kg
Dimension of piston pump	18(L)*90(W)*60 (H) cm / per unit
Weight of piston pump	34kg / per unit



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