Setting the Standard for Automation™

Online Viscosity Measurements

Using a Vibrating type Viscometer to Optimize Process Control and Cut Down Production Costs

Standards
Certification
Education & Training
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- Senior Sales Engineer of Advanced Holdings, a Singapore-listed company which specializes in Analytical Instruments, and Analyzer System Integration.
- Dealing with online process analyzers for the past 5 years including physical property analyzers, Viscometers, NIR spectrometers.

Viscosity

- **Viscosity** is a physical property that describes the capacity of a fluid to flow under the influence of a stress (gravity, for example). Viscosity can be defined as **the resistance of a material to a free flow**
- Viscosity is a key physical characteristics in most of the process industries (oil and gas from drilling to combustion, petrochemical, chemical, biochemical, F&B, pharmaceutical, cosmetics …)
- According to the industry, the process and the product, viscosity is

  the relevant product's characterisitcs,

  correlated to another key parameter,

  impacting the efficiency of its utilization process,

  allowing phase detection.

Introduction

- Viscosity at process temperature
  - → Batch processes
  - → Inline viscometer
  - → Relevant information when viscosity is impacting the utilization of the fluid
- Viscosity at reference temperature
  - → Continuous processes
  - → online viscometer / viscosity analyzer
  - → Relevant information when viscosity is used to characterize the quality of the fluid and the effect of temperature must be eliminated

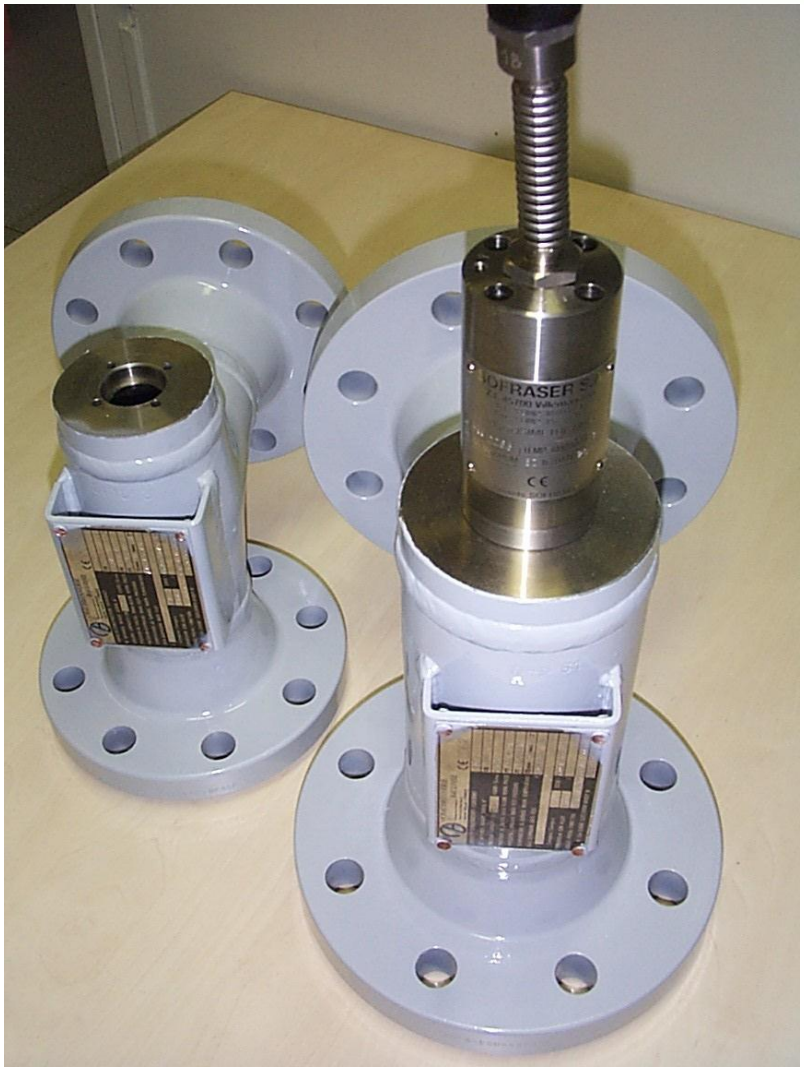
Why measure viscosity at reference temperature?

The measurement is required when:

- The effect of **variable process temperature has to be eliminated**
- The viscosity **has to be measured at a reference temperature**
- **The viscosity is correlated to another working property** of the product
- The **process temperature is much higher than the working (reference) temperature** of the end product

Solution 1

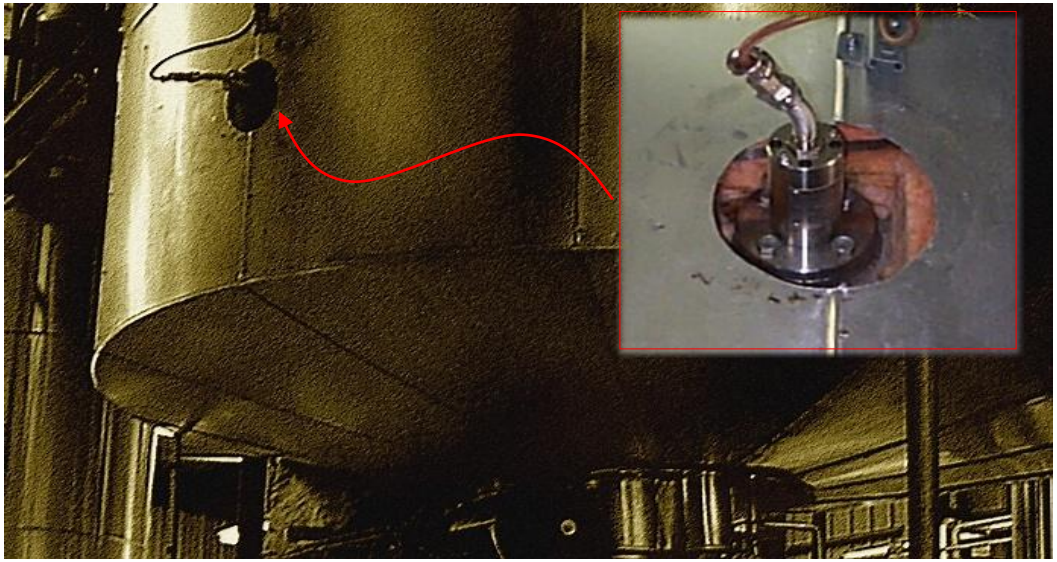
Inline process viscometer with temperature compensation



Measuring viscosity at reference temperature and calculating the viscosity value at reference temperature satisfies basic requirements, but isn't product behavior error-proof.

Advantages	Drawbacks
A single inline viscometer with instantaneous and continuous measurement	Calculation uncertainties - Accuracy decreases as the difference between process temperature and reference temperature increases
Measurement reliability	Reference product behavior must be known
Minimal labor / monetary investment	Product behavior is not error-proof

Inline process viscometer with TCV
Example of applications



Refineries

Petroleum, oil,
liquid hydrocarbons,
heavy and light fuel blends

Lubricant producers

Lubricants, hydraulic fluids

Chemical industry

Polymers (lacquers, varnishes, resins)

Food and beverage

Dry extract

Solution 2

Viscosity at reference temperature analyzer

Viscosity at reference temperature analyzers are measuring viscosity at the reference temperature

Analyzer Advantages
The measurement is made at the actual reference temperature, regardless of product behavior
The correlation to ASTM standard can be done directly
Accuracy is induced by the measuring principle , not by a calculation approximation

Viscosity analyzers at reference temperature

Online analyzers at reference temperature

Capillary systems

With bath or oven

- Sample flows through a conditioning system, enters the bath or oven, and is maintained at a preset temperature
- A pumping system brings the sample to a constant flow, and puts a portion through a capillary system
- Pressure measurement is converted to output signals

Other systems including vibrating systems

With integrated measuring chamber

- A product sample is isolated in measuring chamber
- A controlled cooling or heating phase raises (or lowers) sample to reference temperature (e.g. 100°C), and the measurement is memorized

Case study

- **User**: Lubrizol producer of polyisobutylene
- **Challenge:** Viscosity is the key parameter to maintain the product's quality, and is very time-consuming in terms of sampling for viscosity control
- **Solution:** Implementation of online viscosity analyzer at reference temperature (Thermoset MIVI)
- **Results:** Reduction in sampling down-time, technological optimization, and time savings in maintenance, production, and analysis.

Analyzer

- Thermoset online viscosity analyzer

- Cyclic operating principle
- Using Sofraser tuning type viscometer
- Adapted to high viscosity applications up to 10,000 cP at reference temperature

On field validation

- Thermoset online viscosity analyzer is compared with laboratory measurement 3 times per day

- To validate production mode, the 2 measures are tracked on a control map
  - Without the viscometer, the sample must be measured at least every 2 hours
  - Down-time is ½ hour per sample

Reference

Euroforum conference, Inline viscometry

La Villette, France, November 2001

Technology Benchmark
User data

	Capillary type	Vibrating type
Exterior circulation pump	1	None
Exterior rotative filter	1	None
Security valve in external loop	1	None
Pressure gauge in external loop	2 with separator	None
Tracing	With insulation	Hot box
Entry filter analyzer	1< 200 mesh	1< rough
Moto-reduction for internal pump	1	1
Agitating coupling	1	None
Agitator	1	None
Commutation valves	2 in oil bath at 150°C	2 in the air

Technology Benchmark
User data

	Capillary type	Vibrating type
Security valve in external loop	1 in oil bath at 150°C	2 in the air
Measuring chamber or capillary	3 in oil bath at 150°C	1 in the air
Measuring sensor	Transmitter with separator	Rod
Precision thermometer for set up	1 with mercure	1 resistance probe
Regulating electronics	1 on unit	1 in technical room
Regulating probe	1 in oil bath at 150°C	1
Heating resistance	1 in oil bath at 150°C	1
Cooling exchange	1 in oil bath at 150°C	None
Box for active parts	1 in oil bath at 150°C	1 box in the air
Temperature conditioning fluid	Oil at 150°C	Air at 60°C
Scale commutation electronic	1 in technical room	None

Synthesis of the on field validation

- Without an online viscometer:

  2190 sampling hours

- With an online viscometer:

  547 hours of sampling

  + 39 hours for maintenance control

  + 6 hours for diagnostic maintenance

  + 8 hours for curative maintenance

- **SAVE: 1590 hours per year**

COST ANALYSIS

		Existing solution	New Analyzer
CAPEX	**Analyzer Cost**	From $50k (Average $75k)	From $35k
	Conditioning system	From $25k (Average $50k)	-
OPEX	**Maintenance Cost (hour cost @ $65)**	$22k/year	$3.5k/year
CAPEX + OPEX per year		From $97k 1st year $22k/year afterward	From $38.5k 1st year $3.5k/year afterward
TOTAL COST OVER 10 YEARS OF OPERATION		**From $317k**	**From $73.5k**

Results After Implementation

- Risks for maintenance operators reduced
- Preventative and curative maintenance costs minimized
- Prevention of non-conformities increases product quality
- Reduction in spare parts / inventory levels
- Energy efficient

Thanks for your attention

- Questions ?

ISA Analysis Division

1st ISA Analysis Division Singapore Symposium 2017

6th December 2017

One Farrer Hotel & Spa - Singapore

- Join presenter on Advanced booth A2