# Relative Thickness Index in hydrocarbon measurement

White Paper on measuring emulsions in dehydration processes

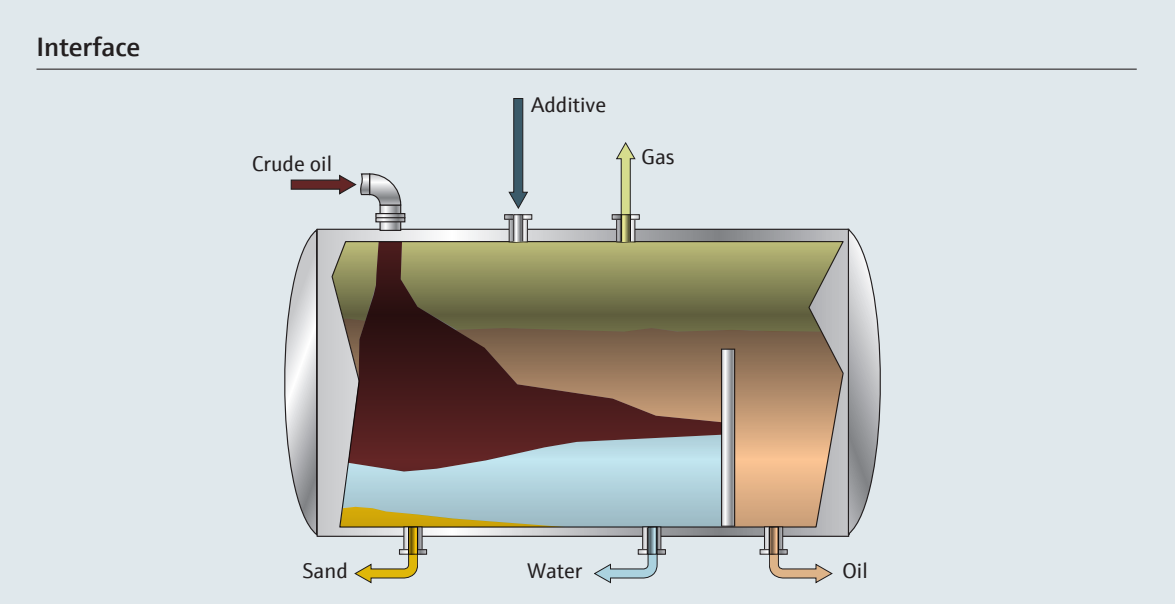
Endress+Hauser

People for Process Automation

# Register

# 1 The challenge of hydrocarbon measurement

From the well the produced oil streams to the separator, where the multiphase fluid is separated. The gas leaves the separator at the top, the water at the bottom and the layer of oil should be going out to the gathering. As very thin entrained sand sits on top of the water, the oil can bond itself with the sand and thereby an emulsion (rag) layer grows. When measuring level in a separator, this emulsion layer can make the actual measurement quite tricky. The emulsion is not easily detectable and when not detecting it, it will create issues downstream of the separator.




# 2 Separator applications at an energy producer

The following case was initiated by a leading energy producer in North America. Its company history with predecessor companies goes back to the world's oldest petroleum companies.

One of the pillars of their oil producing strategy is operational excellence, which they also regard as their competitive advantage. They always strive for increasing profitability by operating in an efficient and cost-effective manner. Summarized they say: "Our best-in-class operators will focus on efficiency, safety & integrated and collaborative thinking in order to maximize value across our asset base."

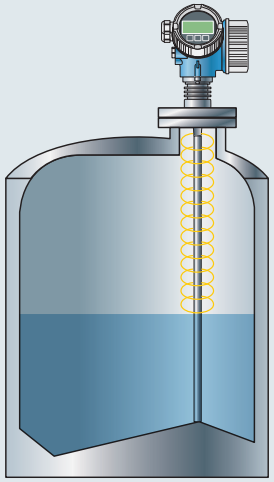
The company deals regularly with emulsion or rag layers, in their separators. They found that very light and fine sand collects on top of the water and allows oil to bond, which starts the accumulation of the emulsion layer. The two main problems with emulsion are (1) to perform a good level measurement and (2) it causes issues downstream in the form of excessive wear of their mechanical equipment. The latter caused intensive maintenance, which meant interruptions of the plant availability.

Concerning the energy producer's objectives in operational excellence they used their collaborative thinking approach and cooperated with the Canadian School of Hydrocarbon Measurement in Calgary. A student there, Jonathan Kohout, started to research and involved experts from Endress+Hauser, Jason Riegert and Gerhard Jansson, for measurement devices.

## 3 On search for the right technology

The idea of the experts was to find an indication showing clearly when an emulsion occurs and how thick it is. Capacitance instruments were of favor in the existing processes, but they got problems with the signals facing the emulsion layers. The other option for them was guided wave radar technology.

**Guided wave radar technology**



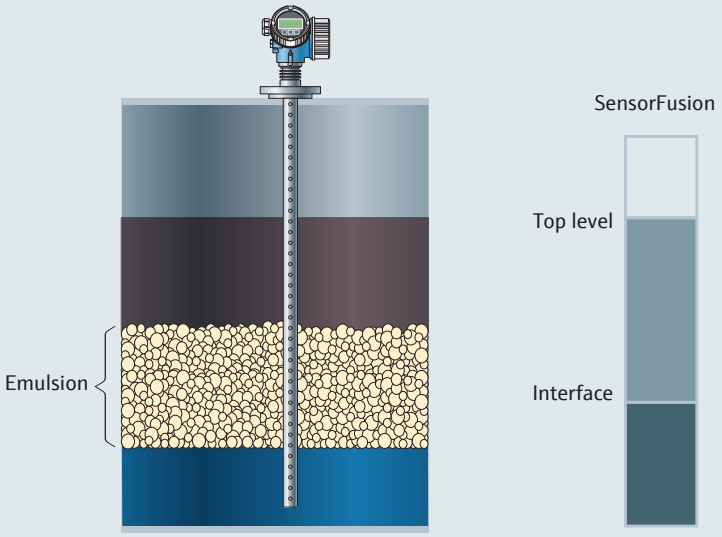
As described in report 547 of the International Association of Oil and Gas Producers, IOGP, the technology of guided wave radars is based on the Time Domain Reflectometry principle (TDR). Low power nanosecond pulses are guided along the probe submerged in the process media. When a pulse reaches the surface of the material, part of the energy is reflected back to the transmitter. The time difference between the generated and reflected pulse is converted into a distance, from which the total level or the interface level is calculated.

As the signal is travelling through a fluid it is slowing down. How much it slows down is determined by the relative permittivity of the fluid, also known as the dielectric constant (DC) value. The DC value of water is bigger than of oil. This needs to be taken into consideration when calculating the second or maybe third interface level which the signal slows down. Therefore, it is relevant to know what is in the tank.

## 4 A combination was needed

The objective of the experts looking for the right way to measure qualitative parameters about the thickness of emulsions was a combination of the favorized capacitance instruments and guided wave radar. In the Levelflex series they found SensorFusion, combining the two measuring principles into one device.

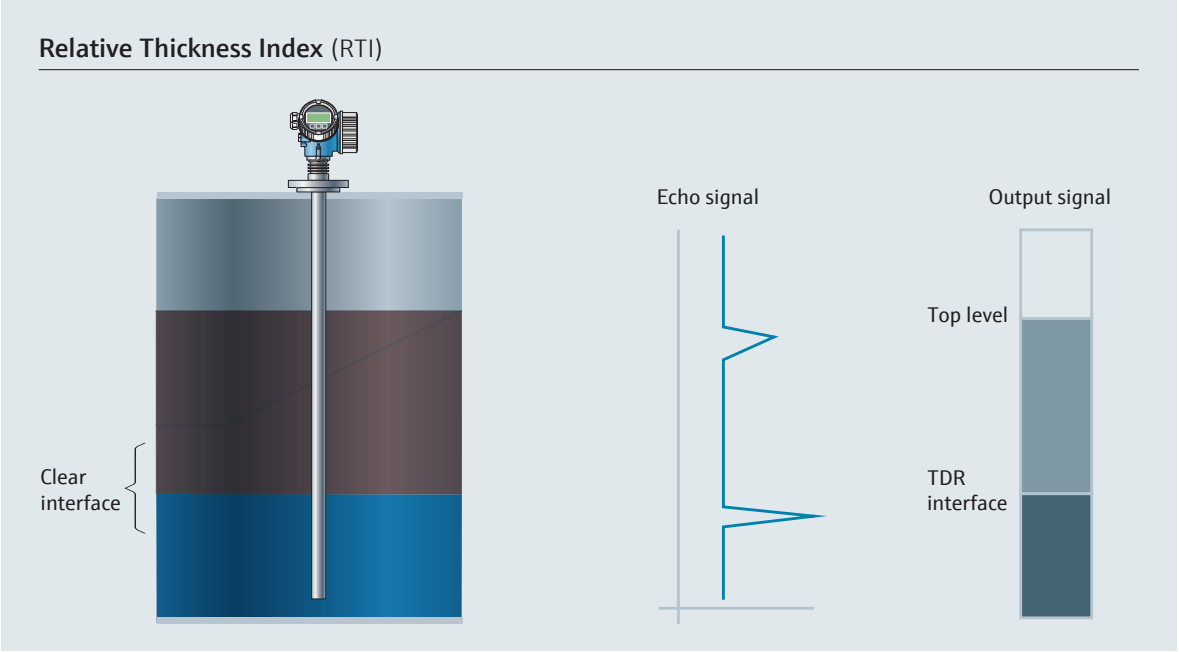
**SensorFusion**




In traditional interface measurement one would lose the interface signal when emulsion emerges. Usually this results in process upsets for the operator. So process upsets tell the operator there is an emulsion, although not how much. The combination of capacitive and guided wave radar in one instrument allowed the detection and measurement of the interfaces between water, emulsion and oil by reading the Relative Interface Echo Amplitude (mV). Still the experts had to put a meaning behind the numbers in order to contextualize details about the emulsion layer.

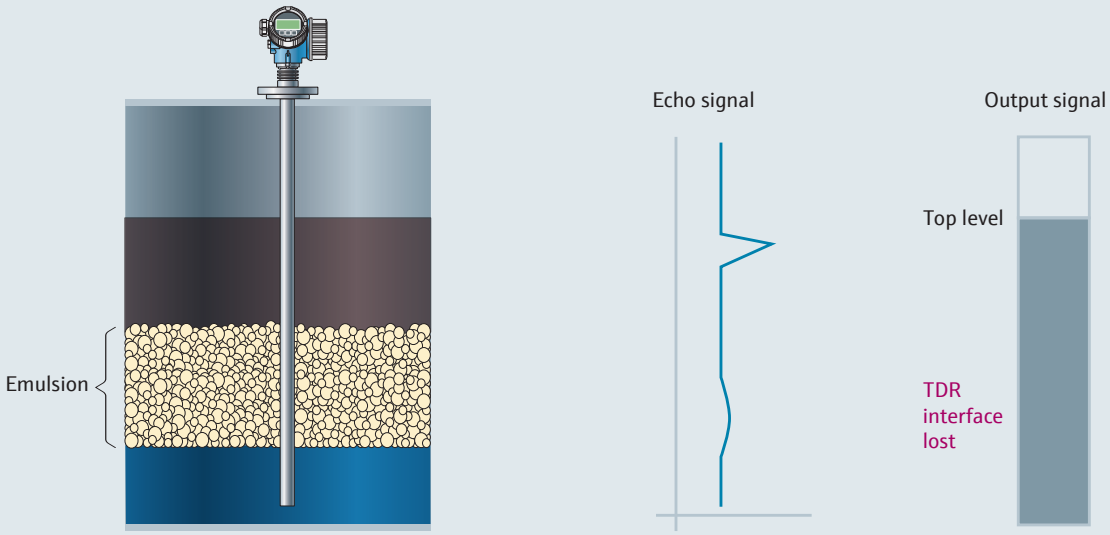
## 5 Comparison of Echo Amplitudes

So the experts looked at the different Echo Amplitudes. It provided them the contextualized details about the emulsion as they created an index as qualitative parameter, which they called the **Relative Thickness Index (RTI)**.




At a clean interface of water and condensate the Relative Interface Echo Amplitude is higher than 70mV.

**Relative Thickness Index** (RTI)




What they found was a Relative Echo Amplitude dropping to around 30mV (Relative Thickness Index 30) as soon as emulsion occurred. The emulsion was about 25-50mm. As the emulsion is getting thicker to about 80-100 mm (RTI of 10 or less) the Relative Interface Echo Amplitude drops further. Even when they lost the Relative Interface Echo altogether (0mV) the instrument FMP55 still measured with the capacitance probe.

## 6 The outcome for the company

With the Relative Thickness Index the North American company controls emulsion. When they realize a clean interface they maximize separator through-put and bring the interface level very high near the top of the weir. As soon as the value of the Relative Thickness Index drops toward 30 they know that emulsion is forming. Then they increase the retention time in the separator by lowering the interface. If the RTI shows that emulsion is getting a problem the company discharges the fluid to a slop tank, where different chemicals and more retention time can be allowed to improve separation.

As a result the North American energy producer evaluated the following benefits of working with the Relative Thickness Index to control their separator applications:

- Less sand downstream of the separator
- Valve trim kits lasting longer as they drop messy emulsion to the slop tank and save the mechanical equipment downstream from excessive wear and maintenance
- Increased through-put
- Maximized plant availability through less maintenance of downstream mechanical equipment

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