APPLICATION REPORT

HEAVY RESIDUE - SIL

Oil & Gas / Downstream

"Safety always comes first for petrochemical companies, it is what we want ... no leakage and no clogging in long-term operation."

Xiaosan Wang,
Project Manager H-Oil unit,
Sinopec ZRCC.

Measuring Task

Mass flow measurement of natural gas in the inlet to Safety-relevant flow measurements in the Hydrocracking Unit of Sinopec Zhenhai Refining & Chemical Company (Sinopec ZRCC)

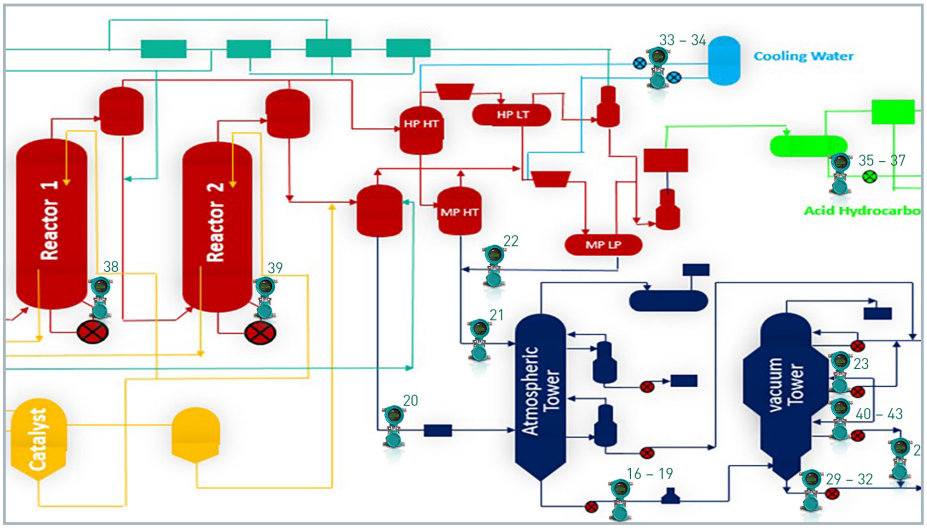
As China's largest integrated refinery and chemical complex, Sinopec ZRCC has a hydrocracker in addition to many other refining units. Hydro-cracking is a refining process for upgrading low-quality heavy gas oils from the atmospheric or vacuum distillation tower, the fluid catalytic cracker and the coking units into high-quality, clean-burning jet fuel, diesel, and gasoline.

A hydrocracker takes gas oil, which is heavier and has a higher boiling range than distillate fuel oil, and cracks the heavy molecules into distillate and gasoline in the presence of hydrogen and a catalyst. There are two main chemical reactions occurring in the hydrocracker: catalytic cracking of heavy hydrocarbons into lighter unsaturated hydrocarbons and the saturation of these newly formed hydrocarbons with hydrogen. The catalytic cracking of the heavier hydrocarbons uses heat and causes the feed to be cooled as it progresses through the reactor. The saturation of the lighter hydrocarbons releases heat and causes the feed and products to heat up as they proceed through the reactor.

There are various types of hydrocracking with different ways to bring the residue feed, catalyst and hydrogen to reaction. The hydrocracking unit at Sinopec ZRCC uses the ebullated-bed technology to process heavy feedstock residues (atmospheric and vacuum residue) with high metals, sulfur, nitrogen, asphaltenes and solid contents. One major advantage of this technology is that there is virtually no limit to operation time, as fresh catalyst is continuously added and spent catalyst withdrawn to control the level of catalyst activity in the reactor enabling constant yield and product quality. Where conventional fixed-bed residue hydrotreaters are limited to catalyst cycle lengths, the patented process can achieve the two to four-year turnaround cycles to match that of the FCC unit and requires only one or two reactors.

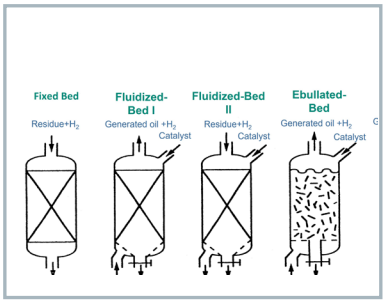
Handling heavy crudes and residues as feedstock requires balance, control, and careful attention to instrumentation selection to ensure operational performance of the plant is maintained and uninterrupted. One major challenge of all hydrocracking technologies lies in their process conditions. Hydrocracking combines high temperatures with high pressure. In Sinopec's hydrocracking unit at Ningbo, the reactors need to operate at high temperatures up to 875 °F with pressure up to 4,200 psi to keep the high conversion rate of residual oil.

The conventional flow measuring instrumentation of heavy hydrocarbon processing plants still consists of ΔP meters such as orifices or wedge meters. It was originally planned to install wedge meters when construction of the hydrocracking unit began in summer 2017 at Sinopec ZRCC, despite the fact that the shortcomings of ΔP measurements are well known. ΔP measurements are challenged by both the viscous fluid with its high content of coke particles and by the metal catalyst. Both tend to clog up the thin differential pressure lines of the wedge meters which in turn require a lot of maintenance. Therefore, both operator and licensor agreed that these would not be optimal for the types of crudes the plant would be processing and could create potential leak points and blockages resulting in potential plant shutdowns, etc. They started looking for suitable ultra-sonic metering instrumentation that could cope with dirty mediums and extremely high temperatures. Furthermore, it was important that said technology could be standardized in the plant and could be used in Proportional-Integral-Derivative (PID) control and Emergency Shutdown applications where zone 1 explosion-protected equipment with SIL2 certification is required.

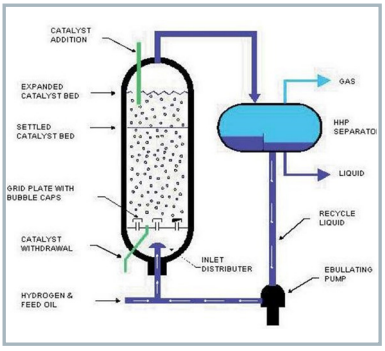


General view over Sinopec's Zhenhai Refining & Chemical Company in Nimbo

The new Hydrocracking Unit by night



Types of Hydrocracking



The Ebullated-Bed Hydrocracking process utilized at Sinopec's ZRCC

The Sinopec ZRCC hydrocracker under construction

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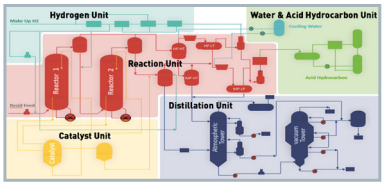

Sinopec ZRCC's hydrocracker comprises five processing units.

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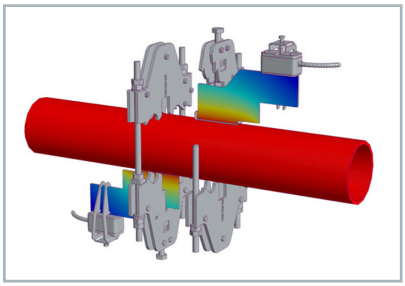
Solution

When it comes to measuring the flow of complex media, instrumentation experts are more than happy to resort to non-intrusive technology.
With its patented WaveInjector®, Flexim has pioneered the way of non-intrusive ultrasonic flow measurement in refinery applications. The high-temperature transducer mounting extends the operation range of Flexim 's clamp-on measuring technology to temperatures up to 1,170 °F. Since its introduction almost twenty years ago, the WaveInjector® has proven to be a superior solution to conventional wetted measurement in countless applications all over the world. As it is a purely mechanical device which simply separates the transducers thermally from the hot pipe, it can be operated in hazardous zones as well as in

safety-critical applications.

After intense discussions, exhaustive investigations, comparisons of technologies and empirical verifications of their respective performances, Sinopec ZRCC finally decided to replace all wedge meters for high temperature and high pressure flow measuring points in its Hydrocracking Unit by Flexim ’s non-intrusive solution with WaveInjector®.

In total, Flexim equipped 43 measuring points with FLUXUS® clamp-on ultrasonic flowmeters. Installation and commissioning was done during the plant’s start-up in 2020. In comparison with a clamp-on ultrasonic flowmeter of another supplier installed in a unit with normal pressure and temperature, Flexim ’s instrumentation proves to be better in stability and reliability, offering faster response time and requiring lower maintenance.



Operation principle of Flexim ’s patented high-temperature transducer mounting device WaveInjector®: metal plates separate the transducers thermally from the hot pipe while assuring best acoustic contact.

All measuring points are equipped with explosion-proof transmitters. As pictured, three dual-channel FLUXUS® F801SR units for safety-related applications and one FLUXUS® F809 in the background.

Advantages

- Precise and reliable flow measurement from the outside of the pipe
- No wear and tear from the media flowing inside, virtually maintenance-free
- Double channel transmitter version for redundant measurement of challenging media such as heavy residue oil with high solid contents
- Fast response time and SIL2-certified devices for safety-related applications
- Excellent collaboration between plant engineers and Flexim 's local sales and support team

Measuring Points and Instrumentation

Pipelines	OD 1½" ... 22"
Media	Various heavy hydrocarbons (feed oil, vacuum residue, atmospheric tower bottom residue, vacuum tower bottom residue), hydrocarbon water mixture, cooling water e.a
Temperature	up to 880 °F
Pressure	up to 3,900 psi
Measuring Devices	16 stationary ultrasonic FLUXUS® F800SR flowmeters (dual-channel version) with SIL-certification for safety functions 27 stationary ultrasonic FLUXUS® F809 flowmeters 53 high temperature transducer mounting devices WaveInjector

Customer

国石化镇海炼化公司
NOPEC ZHENHAI REFINING & CHEMICAL COMPANY

Sinopec Zhenhai Refining & Chemical Company (Sinopec ZRCC), Ningbo City, Zheijang province, China

Founded in 1975, Sinopec ZRCC is currently the largest integrated refining and chemical company in China. With a crude oil processing capacity of 25 million t/y, ethylene capacity of 1 million t/y, a sea jetty with over 50 million tons of annual handling capacity and a tankage of over 138 million cubic feet, Sinopec ZRCC ranks 17th among the world's largest refineries and is one of the top 10 refineries in the Asia Pacific region.

Under Sinopec's quality policy of "making every drop of oil count", ZRCC commits itself to providing clean products for society, producing intermediate petrochemical products to drive down-stream industry development, developing a variety of high-end petrochemicals. The variety of its refining and chemical products is up to more than 50, including different grades of gasoline, jet and diesel fuels, asphalt and polypropylene plastics etc.

For more information, visit
Emerson.com/Flexim

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