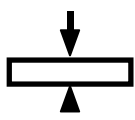


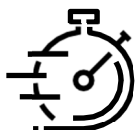
UOP UNITY™ HYDROPROCESSING REACTOR INTERNALS

The next generation has arrived: UOP Unity™ Hydroprocessing Reactor Internals can help optimize your unit's performance, combining a new compact design with the proven functionality of UOP's Uniflow™ Distribution technology.

FEATURES AND BENEFITS



COMPACT QUENCH ZONE HEIGHT
Optimized quench zone design to minimize required space¹



RAPID EQUIPMENT INSTALLATION
Hot-work free, modularized design for fast installation and maintenance²



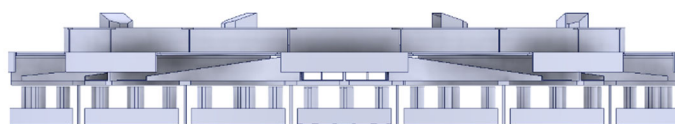
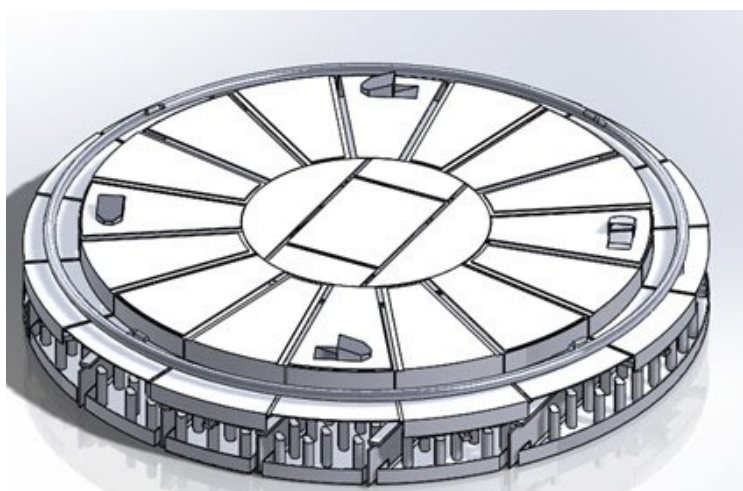
INCREASED CATALYST VOLUME
Short quench zone design for increased catalyst volume in existing units³



IMPROVED UNIT PERFORMANCE
Increased cycle length, more yield, more conversion⁴



DEMONSTRATED RELIABILITY
Excellent performance commercially proven over a wide range of flow rates for increased operating flexibility⁵

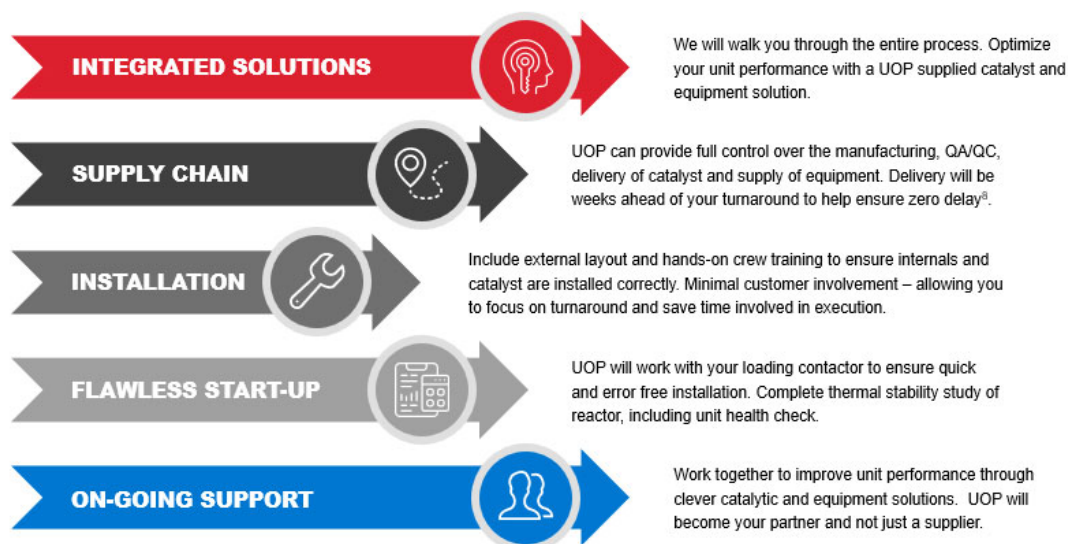


PERFORMANCE VALIDATION

The UOP Unity™ HRI design has been validated by cold flow testing in a commercial scale, 8-foot diameter column installed at UOP's research and development facility⁷. The test column measures flow distribution and quench zone mixing efficiency and provide a unique opportunity for interested customers to view the reactor internals in operation.

Performance validation was completed by measuring distribution over a wide range of liquid and gas rates^{7,9}. In addition, computational fluid dynamics further validated the performance expectations of UOP Unity™ HRI.

CUSTOMER JOURNEY WITH UOP



UOP Unity™ HRI can provide improvements in catalyst volume, catalyst utilization, and unit performance.

For a customer with a 60,000 BPSD hydrocracking unit, UOP's analysis indicated that approximately 3% additional catalyst volume could be added in their existing reactors when switching to UOP Unity™ HRI, resulting in approximately \$2.5 million per year⁶ in unit performance improvement.

Reduced installation / turnaround time² can also provide additional value. Additional catalyst volume can be valued as any combination of high gross conversion, cycle length, or throughput.

COMMERCIAL EXPERIENCE

UOP's hydroprocessing reactor internals technology has been used in more than **300 commercial units worldwide**, including revamp projects, replacement of non-UOP internals, refining, and renewable unit applications.

Uniflow™ distributor trays were commercialized in 2013, with more than **190 trays installed** in operating units worldwide, and over **250 distinct trays fabricated or under fabrication**.

References

1. UOP internal analysis of a range of quench zone heights for varying reactor diameters, demonstrating a consistent height savings with UOP Unity HRI vs previous generation UOP internals in the range of "12 – 24" inches while meeting UOP functional design criteria.
2. UOP experience supervising the installation of HRI in reactors, with a correlation between effort / man-hours required for larger quantities of equipment than smaller quantities of equipment. Modularized design reduces the number of installed components by 20%-30% vs. equivalent previous generation UOP quench zone. For new unit designs, no hot work is required for the scope of UOP Unity™ HRI. For revamp unit designs, UOP will evaluate based on customer reactor configuration, but intends to avoid hot work completely if possible.
3. UOP internal analysis demonstrating the reduction in height required translate to increases in catalyst volume within existing UOP-licensed reactors that do not currently have-UOP Unity™ HRI, depending on customer needs or specific commercial application and pending specifics of catalyst needs by customer.
4. Increases in catalyst volume can provide different operational benefits, which may translate to increased unit cycle length or potential conversion / yield changes according to UOP experience with customers and based on UOP internal analysis with a range of 2 to 10% of additional catalyst volume available or added.
5. Operating data UOP has received on radial temperature spread performance after the implementation of Uniflow distributor vs. previous generation UOP distributors in new and revamped units since 2013.
6. Internal UOP customer study utilizing Reference #1, the calculated (via mechanical layout analysis) catalyst volume available to be added, and assuming a 5 \$/bbl feed to product price spread.
7. UOP performed a range of theoretical, computational, and cold flow simulations to validate the performance of the reactor internals. The 8-foot test column was tested over a range of air to water ratios for the purposes of simulating the range of conditions observed for an operating, refining unit. Air and water testing was primarily done in the fourth quarter of 2020 and throughout 2021.
8. Delivery terms and schedule relative to turnaround are contingent on agreed upon dates of delivery for supplied equipment and catalyst from UOP that are planned to achieve a contractual delivery date in advance of the planned turnaround.
9. Performance validation was done via the testing described in Reference #7, with the targeted goals being measured temperature readings and spreads across various points in the UOP Unity™ assembly via thermocouple readings.

UOP LLC, A Honeywell Company

25 East Algonquin Road

Des Plaines, IL 60017-5017, U.S.A.

www.uop.com

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