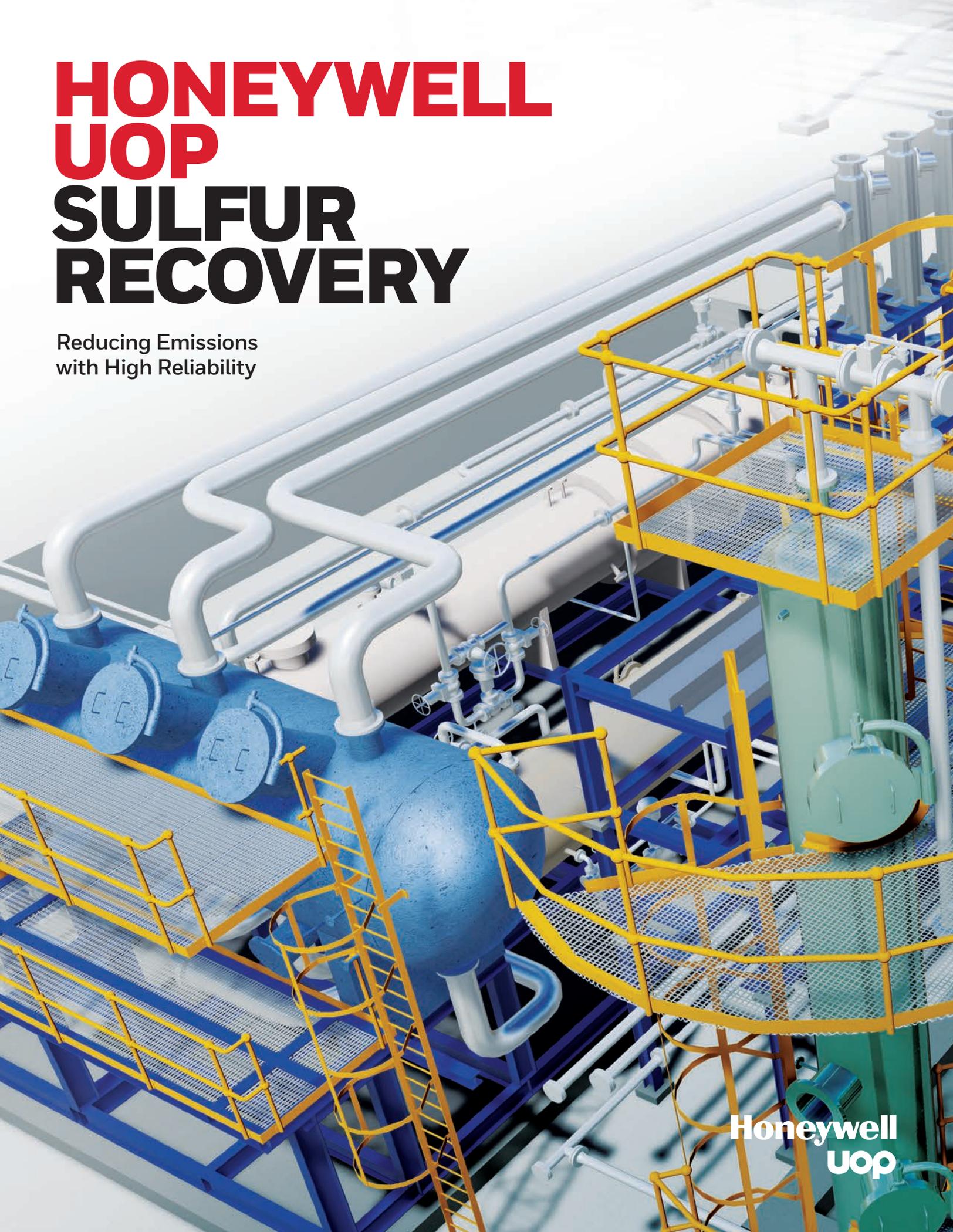


HONEYWELL UOP SULFUR RECOVERY

Reducing Emissions
with High Reliability



Honeywell
UOP

MEET ENVIRONMENTAL REGULATIONS WITH EASE

From a global leader in refining and gas processing technology, UOP's sulfur recovery systems meet the industry's most stringent environmental regulations with high reliability and operational flexibility, leading to increased profitability.

Sulfur is removed as a contaminant from crude oil and sour gas streams to reduce harmful emissions and protect downstream equipment. It can also be recovered as a marketable by product. As sulfur dioxide emissions regulations become more stringent globally, refiners and gas processors need proven sulfur recovery solutions to reliably comply with the strictest requirements.

KEY ADVANTAGES

- Excellent plant reliability with on-stream times of 99-plus percent
- Cost-effective, streamlined modular solutions available
- 30-plus year service lives for robust waste heat boiler designs
- Minimal operator and maintenance attention required
- Longer time between turnarounds with fewer catalyst change-outs

RELIABLE RECOVERY SOLUTIONS

With half a century of Ortloff™ sulfur recovery engineering, design and startup experience and more than 100 installations worldwide, UOP has developed a comprehensive portfolio of sulfur recovery units (SRUs) with high recovery efficiencies and excellent on-stream times. UOP technology stems from the professional adaptation of the best industry processes combined with proprietary technology and expertise. UOP experts work with refiners and gas processors to select the most cost-effective sulfur recovery solution to reliably meet their processing goals.

STAY ON-STREAM

Conventional sulfur recovery units are often plagued with reliability and operability issues that cause costly unplanned shutdowns. Based on continued innovation and hands-on owner/operator experience, UOP has developed unique sulfur recovery unit designs that are more robust, easier to operate and less prone to corrosion and failure. This results in service lives of more than 30 years and significantly minimizes both planned and unplanned shutdowns.

COMMON SRU PROBLEM	UOP SRU DESIGN SOLUTION	BENEFIT
Catalyst deactivation and refractory damage during startup	Cold catalyst bed startup capability design	Allows for startup without warming catalyst reactor beds, reducing the risk of fire or sooting, extending catalyst life and preventing refractory failures
Lost revenue from boiler failures	Robust waste heat boiler design	Eliminates the most frequent cause of extended SRU shutdowns and sulfur shedding with industry-leading performance
Unreliable switching valves	Superior sulfur vapor valve design	Dependable valve designs eliminate solids formation, valve sticking and leakage which can cause high emissions
Tailgas Cleanup Unit (TGCU) startup blower failure	Improved TGCU blower location	Avoids extended shutdowns from water accumulation in the blower casing and reduces emissions during startup and shutdown
Wasting the heat value of the fuel gas consumed in incineration	Tailgas Thermal Oxidizer (TTO) waste heat recovery	Generates saturated or superheated high pressure steam with less fuel gas consumption than an auxiliary boiler

Saving between \$2 million to \$20 million per turnaround for a 400 kbpd refinery

UOP SRU SOLUTIONS

UOP Ortloff Modified Claus Process

The Modified Claus Process is the workhorse for sulfur recovery and is used worldwide in more sulfur plants than any other process. The Modified Claus Process can achieve up to 97 percent sulfur recovery efficiency and produces very high-quality sulfur, free of contaminants.

In the typical Modified Claus Process, the acid gas feed is partially oxidized to generate sulfur dioxide, which then reacts with the remaining hydrogen sulfide over a catalyst to produce sulfur. Most Claus sulfur plants contain two or three catalytic stages and can be followed by a tailgas cleanup process and/or a UOP Callidus® TTO.

UOP Ortloff Tailgas Cleanup Processes

For higher sulfur recovery efficiencies, UOP Ortloff sulfur recovery processes can be combined with a wide range of

tailgas cleanup processes to achieve recovery efficiencies up to 99.95 percent. UOP combines proprietary plant design knowledge and equipment with licensed industry processes for improved operational efficiencies and fewer maintenance problems.

These processes include:

- BP Amoco's Cold Bed Adsorption (CBA) Process which modifies the standard catalytic Claus reaction by operating below the sulfur dew point temperature for 99-plus percent sulfur recovery
- Shell Claus Off-gas Treating (SCOT), the most widely recognized amine-based tailgas cleanup process
- UOP Callidus Tailgas Scrubbing which all but eliminates SO_x emissions with a cost-effective, highly reliable system

UOP Selectox™ Processes

The Selectox and Recycle Selectox™ Processes recover sulfur from dilute acid gas streams by using a specialty catalyst and process flow scheme.

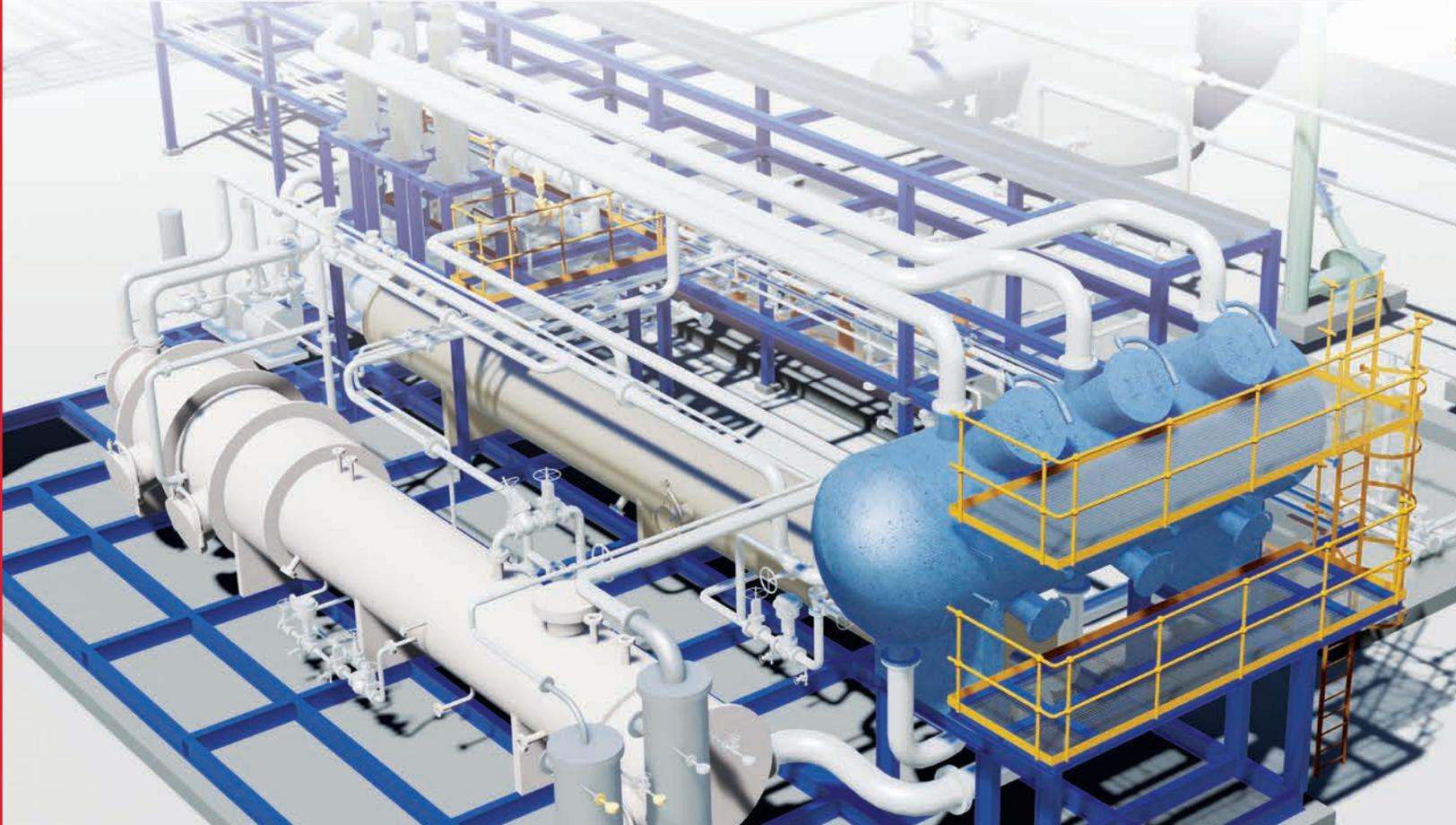
These cost-effective technologies can recover sulfur from gas streams ranging from 0.5 to 45 percent hydrogen sulfide. By following the Selectox process with Callidus Tailgas Scrubbing plants can achieve very low SO₂ emissions.

Modular Solutions

UOP's modular sulfur recovery solutions are based on a streamlined design and fabrication process. With extensive modular equipment experience, UOP solutions offer proven high reliability, lower costs and faster delivery. The pre-engineered, factory-built approach allows for predictable expenses and schedules, so refiners and gas processors can stay on budget and on schedule.

EXAMPLE UOP SRU PORTFOLIO PERFORMANCE

TECHNOLOGY	RECOVERY LEVEL	SO _x EMISSIONS	RELATIVE CAPEX
3-Stage Claus + TTO	95-97%	4,000 – 10,000+ ppmv	1.0
2+2-Stage Claus/CBA + TTO	98-99.3%	500 – 1,500 ppmv	1.2 – 1.4
3-Stage Claus + TGCU + TTO	99-99.95%	50 – 500 ppmv	1.8 – 2.0
2+2-Stage Claus/CBA + TTO + TSU	99.9+%	25 – 500 ppmv	1.4 – 1.6



ONE-STOP SHOP

As a leading process licensor, UOP offers a full scope of integrated solutions for the refining and gas processing industry. With UOP as a single-source provider, operators can benefit from:

- Improved process unit integration and an optimized flow scheme
- Efficient project execution and reduced schedule risk
- Guaranteed performance
- Simpler negotiations

DEDICATED AFTERMARKET SUPPORT

From start to finish, Honeywell UOP global sales, engineering, service and support staff is there to understand customer goals and ensure needs are met with proven products and technology. Honeywell UOP's dedicated customer support organization addresses aftermarket needs, including revamps, debottlenecking and capacity increases, process performance improvement, hardware upgrades, operations training and field support supervision. Extensive service offerings, coupled with unmatched technical knowledge and experience, can help refiners and gas processors focus on profitability.

CONNECTED PLANT

Honeywell UOP's connected solutions and services ensure that refining and gas processing plants run at the peak of their capability. The Honeywell Connected Plant is a suite of applications that delivers higher levels of safety, reliability, efficiency and profitability. These proven industry solutions are based on Honeywell's decades of domain knowledge and controls experience. A connected plant turns data into actionable insight to optimize operations, predict plant failures and eliminate unplanned downtime.



MORE THAN 100 YEARS OF GLOBAL EXPERIENCE, AND COUNTING

UOP provides process technology, materials, and equipment for the gas processing, refining and petrochemical industries. With 19 engineering and R&D centers and 14 manufacturing facilities in 19 countries, UOP is close to its customers wherever they are. Since 1914, UOP has developed more than 70 licensed processes and 5,000 active patents and applications for the industries served.

For More Information

To schedule a call or an onsite meeting to review your operation and needs, contact us at +1-847-391-2000 or visit uop.com.

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UOP8442 | 10/19
Printed in U.S.A.
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