PETROLEUM

Project Fact Sheet

An Office of Industrial Technologies Success Story

AMMONIA ABSORPTION REFRIGERATION UNIT PROVIDES ENVIRONMENTALLY-FRIENDLY PROFITS FOR AN OIL REFINERY

BENEFITS

- Payback of less than 2 years
- Recovers 2.1 million gallons of gasoline and liquefied petroleum gas a year
- Decreases annual CO_2 emissions by 10,000 tons
- Realizes increased profit of $900,000

APPLICATIONS

This technology is widely applicable, not only to refineries, but to many industries. The waste-heat-powered absorption refrigeration unit can be successfully used in mainstream industrial refrigeration applications, such as cold storage warehouses and frozen food processing.

The 27,000 barrel-per-day Denver refinery of Ultramar Diamond Shamrock (UDS) suffered from low profitability and low energy efficiency. One indicator of these problems was the large flare that burned almost continuously. Many refineries, like the UDS refinery, have waste gases that are routed to a fuel header. When the amount of waste gas exceeds the requirements of the refinery furnaces and boilers, the excess is flared. A small fraction of the waste gas is propane (C_3) or heavier—about 4% by volume. If it can be recovered, the refinery can sell the C_3+ as either liquefied petroleum gas (LPG) or gasoline. But, at a low partial pressure present in the fuel header, the C_3+ will not condense at ambient temperature and thus can not be recovered. Calculations show that about half of the C_3+ can be condensed by chilling the waste gas to -20°F (-29°C).

Solution

The refinery convened a team of experts to devise the best solution. The team considered a number of approaches before deciding on the waste-heat-powered absorption refrigeration unit (ARU). The gaseous effluent from the reformer proved to be an ideal target for applying the refrigeration. Chilling that stream to -20°F at nominal refinery summer operating conditions recovers 200 barrels-per-day of liquid C_3+, which is more than enough to extinguish the flare.

Solving the problem with a waste-heat-powered ARU also requires a suitable source of waste heat. A good source was found at the reformer. The cooling curve showed that the required 6 million Btu/hr (1758 kW) of waste heat could be extracted from the target stream by cooling it from 290°F to 260°F.

The ARU is directly integrated into the refinery processes and uses enhanced, highly compact heat and mass exchangers.

ABSORPTION REFRIGERATION UNIT

Results

The ARU is recovering 200 barrels-per-day of LPG and has recovered as much as 315 barrels-per-day. The unit also has achieved the design chilling temperature of -20°F. It is always operated to achieve the lowest possible temperature and routinely achieves -50°F during the winter.

It is now very rare that any gas is released from the refinery fuel header into the flare header. The average LPG recovery is at least 50% more than what was formerly flared, so it is usually necessary to import natural gas to make up the deficit. The recovered liquid falls 60% within the gasoline fraction and 40% in the LPG fraction. Thus, it may be considered that the natural gas is being converted into gasoline and LPG at effectively 100% thermal efficiency, with excellent economic value added.

An integral part of the project is the associated reduction in regulated emmissions. Recovering salable hydrocarbon products from the refinery fuel gas system substantially reduces the amount of flared fuel gas. This not only saves money and reduces wasted energy, but also lowers emissions from the refinery flare. Additionally, reducing the flared fuel gas minimizes the size of the flare; large flares from refineries are often a source of complaint among neighboring communities.

The Association of Energy Engineers designated this project "Enviromental Project of the Year" for 1998.

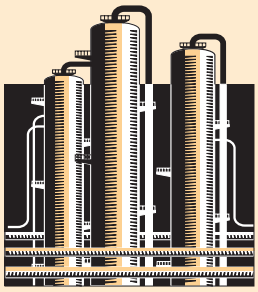
Summary of Costs and Benefits

	UDS Project	Next Project
Total cost	$2.3 million*	$1.55 million
DOE cost-share for demonstration-related costs	$0.76 million	$0
Net cost	$1.55 million	$1.55 million
Total cost benefit of unit (based on 2.1 million gallons/yr of petroleum products recovered at $.50/gal, minus $150,000 in increased cost of purchasing natural gas and electricity)	$900,000	$900,000
Payback	2.5 years	1.7 years

**Since this unit was the first-of-a-kind, the cost was appreciably higher than future units will be. The DOE cost share was used to cover non-recurring, demonstration-related costs (e.g., development costs associated with the absorber, design, fabrication and testing of prototype).*

Emmissions Reductions

Pollutant	Reduction (tons/yr)
CO	9.91
NO_X	1.82
PM_{10}	0.07
VOC	1.5
CO_2	7.741



Project Partners

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