Johnson Matthey
Process Technologies

CATACEL JM SSR

Case Study – Can Reformer

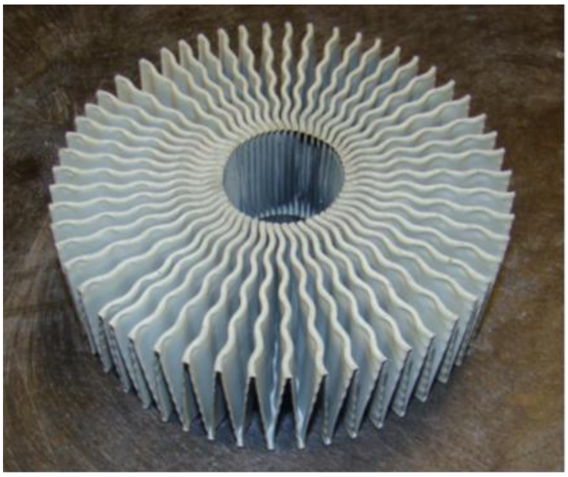
November 2015

Catacel SSR JM

Introduction

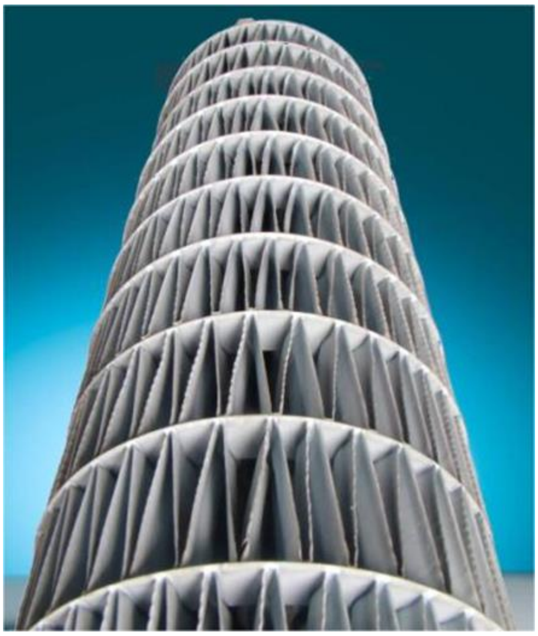
CATACEL$_{JM}$ SSR^{TM} is an engineered thin-foil structured catalyst for industrial steam methane reforming. It is produced by forming alloy strip into engineered foil supports called fans (Figure 1). The fans are coated with a promoted nickel based steam reforming catalyst using a proprietary coating process that ensures a robust, durable and long-lasting coating is delivered. The fans are quite "springy" and can easily be pulled or pushed into different diameters or shapes. The promoters in the catalyst allow reduction and start-up of the catalyst on process gas. No reduction process is required for this catalyst.

Figure 1. CATACEL$_{JM}$ SSR Fan



The fans are stacked one upon another in the reforming tube, separated by thin metal washers (Figure 2). The outer edges of the fans are located close to, but not touching the internal surface of the tube. The stacked fans deliver superior heat transfer by impinging gas on the internal surface of the reforming tube, rather than relying on convective heat transfer mechanisms. This results in about 20-30% more heat transfer for the same (or lower) pressure drop when compared to traditional catalyst pellets. In addition, the fans offer 1.5 to 2.0 times more geometric surface area than conventional pellets. Variation of the fan geometry allows the technology to be fine-tuned to deliver enhanced heat transfer, activity or pressure drop characteristics depending on the design characteristics (such as tube diameter), the operating constraints (tube wall temperature margins, carbon margins) and the production requirements (such as throughput) of each reformer. This allows CATACEL$_{JM}$ SSR technology to be fully utilized and provide the maximum benefit for every plant.

Figure 2. CATACEL$_{JM}$ SSR Stack



The performance improvements that can be gained with CATACEL$_{JM}$ SSR catalyst are substantially larger than those that can be obtained from ceramic based pellets. The activity and heat transfer performance of the catalyst is markedly improved whilst at the same time pressure drop is reduced. This combination

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generates the potential for significant improvements in steam reformer operation. The heat transfer benefits of CATACEL$_{JM}$ SSR will generate reductions in tube wall temperature thereby increasing the heat transfer efficiency of the furnace which will provide the opportunity for savings to be made in fuel usage. The increased activity of the product will further reduce the tube wall temperature and reduce the methane slip at any given outlet temperature. Additionally, the extra activity and cooler tube wall temperatures will reduce the risk of carbon formation and increase both catalyst and tube lives. The lower reformer pressure drop will reduce the load on compressors, allowing improved plant efficiency or the potential for increases in throughput.

CATACEL$_{JM}$ SSR technology was installed into a customer-confidential steam reformer in the continental United States during February 2015. The installation was successful and twenty tubes were loaded in 1 ½ days as well as two spare tubes. This reformer is a can style and has a rated Hydrogen production of 90,000 scfh. On pellets, the reformer had only operated at a maximum production of ~70,000 scfh due to bottlenecks associated with the burner.

Plant Performance

After three months operation with CATACEL$_{JM}$ SSR technology data was collected for comparison with the previous pellet catalyst performance. Pellet data from October – December of 2014 was compared with CATACEL$_{JM}$ SSR performance data from mid-March to mid-June of 2015.

Plant production rates for those time periods are shown in

Table 1. As seen from the table, the plant operated at higher production rates with CATACEL$_{JM}$ SSR. The highest sustained production rate with pellets was 71,000 scfh and with CATACEL$_{JM}$ SSR it was 90,000 scfh, with several campaigns operating for an extended time at 85,000 scfh. This represents a 20 – 25% increase in achievable production rate, bringing the plant up to its original rated throughput.

Table 1. Production Rate

H_2 Production Rate (scfh)	Pellet (% of Operating Time)	CATACEL$_{JM}$ SSR (% of Operating Time
40,000 – 50,000	24%	8%
50,000 – 60,000	31%	26%
60,000 – 70,000	34%	27%
70,000 – 80,000	N/A	21%
80,000 – 90,000	N/A	11%

The impact on fuel savings was remarkable. The fuel efficiency (Figure 2) of the plant increased from an average of 6.6 scfh H_2 produced for every 1 scfh of fuel natural gas, to 15.5 scfh H_2/scfh fuel natural gas. This is across all production rates and represents a fuel saving of 57%. The overall plant efficiency (measured by considering the total natural gas usage that is required to produce hydrogen) can also be estimated and these data are presented in Figure 3. The impact of the fuel savings seems to trend downward as the production rate increases, but even in the 80 – 90 mscfh range the efficiency is 11.6, equating to 41% less fuel used when compared to the 40 – 50 mscfh range for the pellets.

Figure 2. Fuel efficiency at various operating ranges.

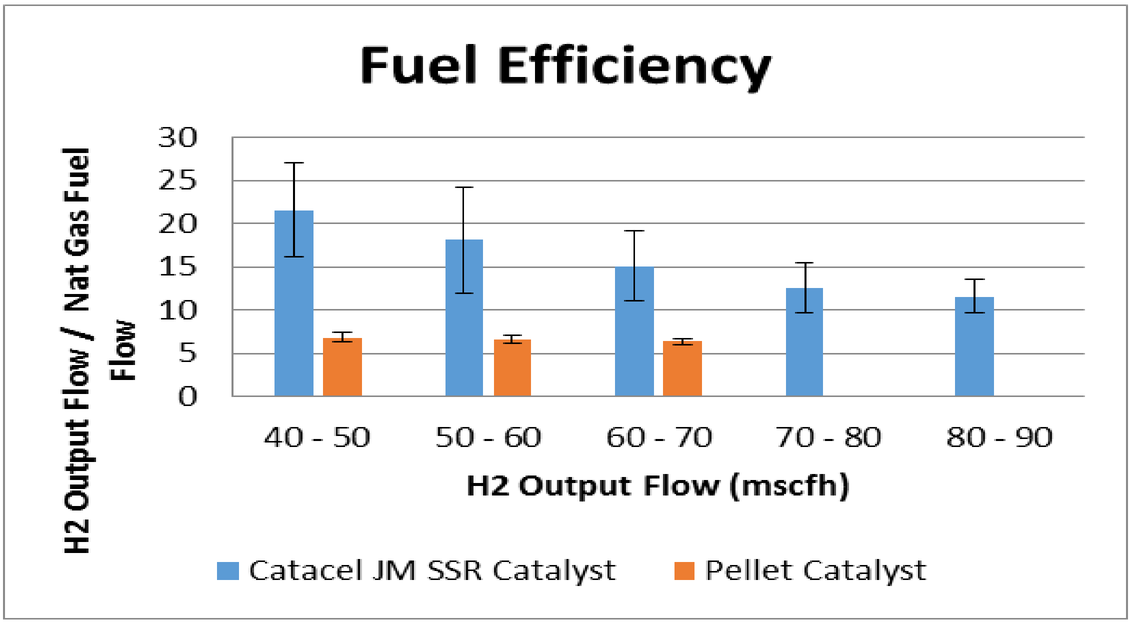
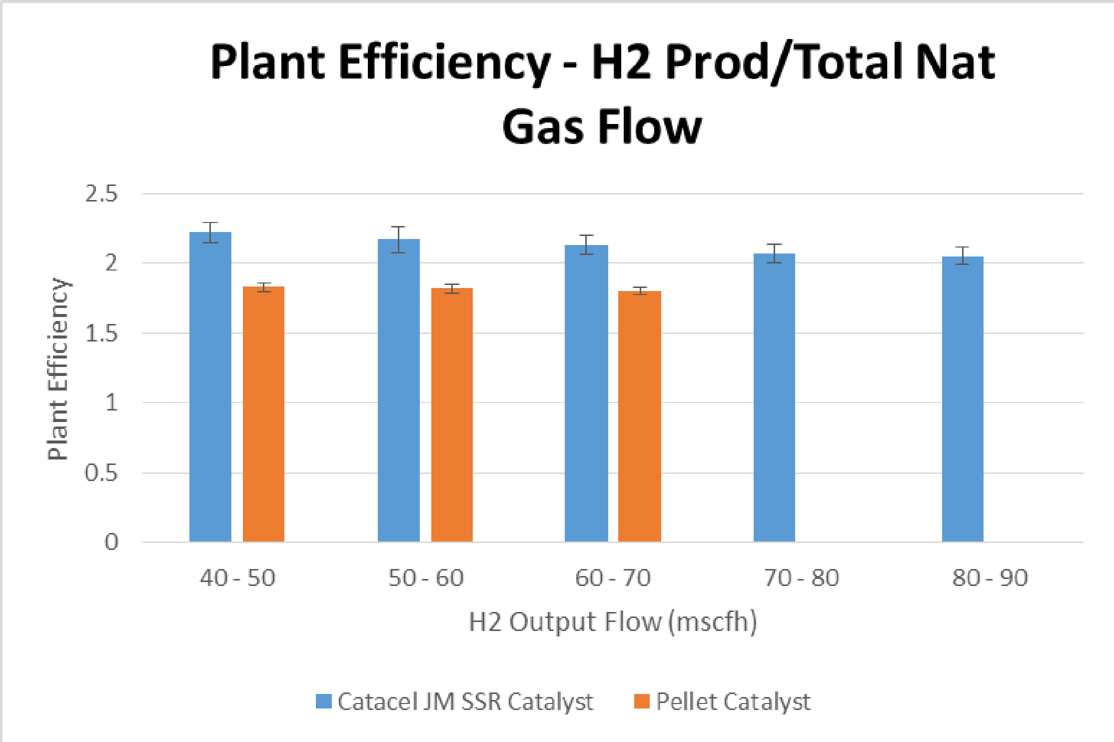


Figure 3. Plant efficiency at various operating ranges.



Conclusions

CATACEL$_{JM}$ SSR technology is delivering excellent performance when compared with pellets in this can reformer. The reformer is experiencing a substantial reduction in natural gas fuel consumption by the burner and the plant has been able to increase throughput by up to 20%. There are likely to have been a number of constraints to heat transfer in this unit but it is clear that CATACEL$_{JM}$ SSR has removed some of the restrictions to heat transfer and this has allowed more efficient use of the fuel and has permitted the unit to operate at increased throughputs.