NOVEL THERMAL OXIDISER DELIVERS OUTSTANDING ENERGY EFFICIENCY

ITC Rubis is a state-of-the-art terminal for the storage of liquefied petroleum gas (LPG) and chemical products. The tank vapours, mixed with nitrogen and air, are vented into a common collection system forming a gaseous mixture, which is classified as an ATEX zone 0 area. The composition of those vent gases will vary considerably in terms of composition and volume (more than 50 storage tanks with different products of which a certain amount will reach venting conditions at any given time due to operations or atmospheric conditions). This variation is illustrated in Figure 2 (the disturbance is shown on the right hand of the figure). In addition to this, some special manual operations are performed, such as nitrogen blowing of lines or draining of small quantities of LPG into the system.

As a consequence of periods with reduced activity at the terminal, vent gas is available discontinous.

Figure 1: Thermal oxidizer units at ITC Rubis, Beveren (BE)

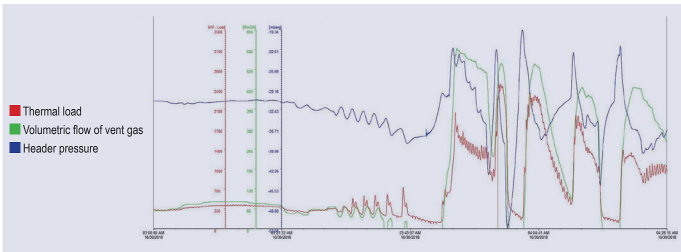

Figure 2: Illustration of the vent gas flow and composition changes

CONVENTIONAL THERMAL OXIDISERS

Prior to the addition of the Dumag thermal oxidiser, ITC Rubis operated two conventional thermal oxidisers with a similar thermal capacity to the new one that has been installed. These conventional direct fired thermal oxidisers with vertical combustion chambers feature what is known as a dynamic flame arrester – a common protection device in systems of this kind. When the flow rate of vent gas falls below a critical value there is the risk of a backflash: the flame will not be introduced into the combustion chamber but burns back towards the source of the vapours. The dynamic flame arrester is used to prevent this using additional air to ensure that the total flow rate does not fall short of the critical low set-point under any circumstances. Additional air is added in the event of a lower flow of vent gas, resulting in an appropriate velocity of the feed stream, which is above the velocity of flame propagation. This additional air flow ensures that the flame is always in the direction towards the stack and will not flash back. However, in order to maintain the combustion temperature (typically above 850˚C) at all times, additional auxiliary energy is needed, precisely at the times when vent gas is very low or does not contain significant organic content. This is unfavourable and causes increased operational costs of the unit (especially in discontinuous operation). Difficulties sometimes occurr in handling varying compositions (calorific value) and changing the amounts of vent

Figure 3: Black smoke due to incomplete combustion during a test run

gas in the existing units, especially during drain operations. Cooling/ combustion air is fed via air inlet with shutters based on the principle of natural draft. The shutters are meant to control the air flow, and thereby the temperature. Due to the size and construction, however, the design could neither provide a quick response to the described changes nor accommodate to the pressure/concentration peaks in the vent gas. As a consequence, a visible flame or eventually black smoke resulting from incomplete combustion could be detected at the stack outlet. The involuntary attraction caused by such event might draw the attention of the neighborhood and authorities (see Figure 3).

THE TECHNICAL CHALLENGE

Dumag was presented with two imperative targets that needed to be met and successfully demonstrated in use for guaranteed performance:

1. Increasing the energy efficiency in 'idle' mode: achieving an overall reduction in auxiliary fuel consumption at low and no vent gas flow.
2. Producing 'invisible smoke': increasing the ability of the installation to accommodate sudden vent gas pressure and composition changes.

The company succeeded in designing, building and operating a skid mounted, modular system meeting all the exceptional targeted performance requirements.

DUMAG CSB BURNER FOR INCREASED ENERGY EFFICIENCY

Dumag installed the proprietary Dumag CSB burner (Figure 4) in the unit at ITC Rubis; this burner is capable of achieving a turn-down ratio as low as 1:30 without compromising in safety. Automatic control of the burner neck position maintains a constant pressure drop resp. gas velocity over the burner. When the amount of waste gas is lower, the burner will adjust, and the cross-sectional area of the burner becomes smaller. This keeps the velocity constant at the burner neck, offers an effective measure against flame flashback and replaces the traditionally used dynamic flame arrester based on flow addition. A significant reduction of the volume of air added (and therefore also additional auxiliary fuel) was possible as a result of this development, and the idle operation state (vent gas flow equal to zero with unit lined up) can now be realised with as little as 10 Nm³/h natural gas, which is needed for compensation of heat losses through the insulation and via the stack.

A verifiable improvement has been achieved. Assuming 2,000 hours of idle time operation per year, a saving of approximately 1,000 MWh of natural gas can be realised (the difference in idle consumption can be seen in Figure 5 as horizontal trend line). This equals more than 200 tons of CO_2 emission reduction per year. Taking an optimistic natural gas price of 0.02 €/kWh as a basis, the expected fuel cost reduction could be at least €20,000 per year.

Dumag has included a hot-standby mode as an important additional feature for the periods when the collection system does not provide any vent gas over an extended period of time. In this mode, the unit temperature is maintained but the vent gas line is closed and a further lowering of the fuel demand is possible as a consequence.

ADVANCED PROCESS CONTROL FOR SMOKELESS OPERATION

The Dumag system features a forced draft air fan which is used to control the O_2 at the stack and the temperature of the combustion chamber. A fast reacting system cannot rely on a single control loop only. Operation is monitored by the advanced process control that is implemented and the future operational conditions are also derived from the measurement input received. Dumag recommends implementing feed-forward-control using a continuous composition analyser upstream the system as a general rule, but this option was not required at ITC Rubis. In the case of the ITC Rubis unit, the flue gas temperature, the vent gas flow and pressure and thermal load and other further relevant process data are all used for controlling the system in addition to the flue gas oxygen content. Dumag has parametrised these control loops in a highly effective system, based on its extensive experience in other successful projects. A clear illustration of this effectiveness is how the system processes a sudden introduction of 500 Nm³/h of pure LPG via the LPG draining system. The Dumag unit maintains full functionality until it reaches its thermal limit (Figure 6).

CONCLUSION

Dumag applied its proprietary technology and extensive process tuning experience gained in various thermal oxidiser applications, and also made full use of its proprietary computer aided engineering tools and its know-how and expertise to provide a suitable solution for the challenges presented by ITC Rubis. Significant operational cost reduction has been realised for situations of low flow and no flow of vent gas. The most important stride forward, however, is that this has been achieved without compromising on safety or operational flexibility.

FOR MORE INFORMATION

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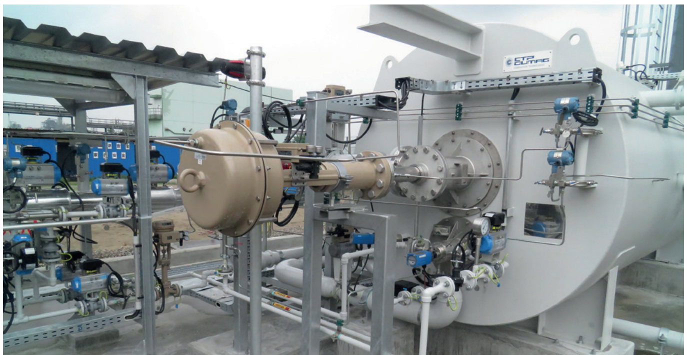

Figure 4: Example of a DUMAG CSB burner device

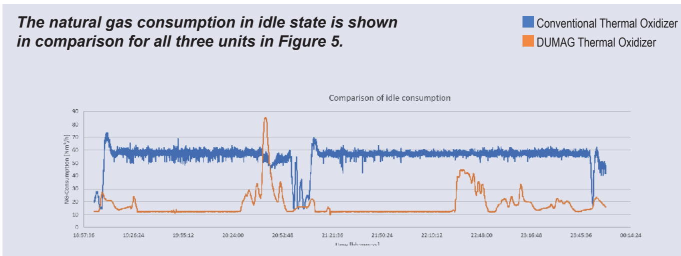

Figure 5: Comparison of natural gas consumption in thermal oxidizers at ITC Rubis during low vent gas flow rates

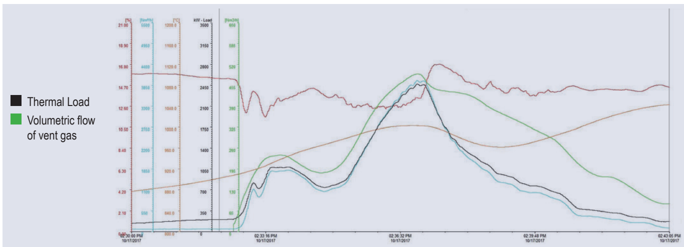

Figure 6: Immediate system response to load changes during peak performance test (500 Nm³/h 1-butene introduced in the vent gas system)