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CALCULATION OF LPG REQUIRED TO PREHEAT A 7.5~TPD SULFUR BURNER

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Introduction

Modern sulfur burners include an auxiliary burner used to bring the system close to operating temperature before introducing sulfur. Preheating the sulfur burner with a different fuel which can generate a very well controlled heat facilitates the even expansion of the various burner components. Bringing the burner closer to operating temperature before starting the sulfur burning prevents both the transmission of unburnt sulfur to downstream equipment as well as the generation of sulfur trioxide which may occur under cooler temperatures at startup. The auxiliary burner is sized to bring the sulfur burner up to at least 540°C for the purpose of preheating the burner. Preheating should progress at a rate no faster than 56°C/h. Various fuels have different heating values [1] and therefore would have different consumption rates and total volume requirements to preheat a sulfur burner. This document illustrates the calculation for a sulfur burner with a 380 kW (1.3 MMBTU/hr) auxiliary burner using liquified propane gas (LPG). For the purposes of comparison, the calculation is repeated with natural gas (NG) at standard temperature and pressure.

Calculation of volume of LPG required

Lundberg has extensive experience with sulfur burners. A “380 kW” auxiliary burner is considered appropriate for a sulfur burner which is sized to burn between 7 and 11 tonnes of sulfur per day, producing 14 to 22 tonnes of sulfur dioxide per day.

We begin the calculation by considering how much heat a burner operating at 380 kW for ten hours (or 36000 seconds) will generate

$$E = P \cdot t$$

$$= 380\ kW \cdot 36000\ s$$

$$= 13.7\ Gj$$

The document in reference [1], from the University of Birmingham in the UK, states that the lower heating value, LHV, of LPG is 47.7 MJ/kg. Using the energy density represented by the LHV, we calculate the mass of LPG required

$$m = e/LHV$$

$$= 13.7\ Gj/47.7\ MJ/kg$$

$$= 294\ kg$$

This mass can be converted to a volume using the density of LPG, ρ = 0.539 kg/l,

$$V = m/p$$
$$= 294\,kg/0.539\,kg/l$$
$$= 545\,l$$
$$\approx 0.6\,m^3$$

Calculation of volume of NG required

The previous calculation is repeated here using the data for natural gas as found in reference [1]. The same size burner is considered, so the energy produced over ten hours, 13.7 GJ, remains the same.

$$V = \frac{E}{LHV \cdot \rho}$$
$$= \frac{13.7\,GJ}{47.75\,MJ/kg \cdot 0.791\,kg/m^3}$$
$$= 363\,m^3$$

Discussion

The increase in size by 621 times essentially represents the difference in the volume of a gas versus that of a liquid. Note that the LHV was nearly the same for these two fuels. A calculation for propane gas would yield a similar result.

In Lundberg's previous experience over many sulfur burners, an auxiliary burner with a capacity of 380 kW is sufficient to heat the sulfur burner body and gas duct to a temperature above 540°C. Early on during heating, less heat is required because the air does not have to be heated as much to achieve a 56°C/h increase. Therefore, during most of the preheating, the auxiliary burner will not be operating at 380 kW. This means that less than 13.7 GJ of heat will be required, and less than 0.6 m^3 of LPG will be required for preheating.

The auxiliary burner is shut off after sulfur is introduced into the burner, since the burning sulfur will supply the rest of the heating necessary to bring the burner up to operating temperature. Full production is not reached until the sulfur burner achieves operating temperature.

Conclusion

A larger tank should be supplied for a 7.5 TPD sulfur burner. Lundberg recommends a tank which is 2 to 3 times larger. This will ensure that there is enough gas available if there are any mishaps during start up. Therefore, for a 7.5 TPD sulfur burner, a 1.2 to 1.8 m^3 tank should be supplied.

References

[1] Iain Staffell. The energy and fuel data sheet. http://www.claverton-energy.com/wp-content/uploads/2012/08/the_energy_and_fuel_data_sheet.pdf, March 2011.