Nanoil Technology Retaining Colloidal Stability at High Concentration for Maximum Energy Conservation

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ABSTRACT

NanOil is based in Denmark and provides tailor made solutions for a number of industries that consume large quantities of diesel-based fossil fuels and in turn reduces their dependency on said fuel sources. The NanOil equipment will mix a quantity of water with the fuel source, and a chemical additive to improve the combustion characteristics of the fuel.

Introduction

NanOil can offer the equipment, the additives, the training, the expertise and the experience in the subsequent use of the emulsion fuel and how to ready the current installations for this change. NanOil will train the customer's own technical staff to be able to handle any pressing technical issues and thereby be in the best possible situation to make the switch to emulsion fuel. NanOil will furthermore provide technical assistance both on and off site, should it be needed.

The nature of the system that NanOil provides is very technical and the following pages will provide a short version of the technical aspect. Should there be any initial interest in the product, all technical matters and questions can be reverted to NanOil Denmark and we will make sure that the customer is provided with the needed information.

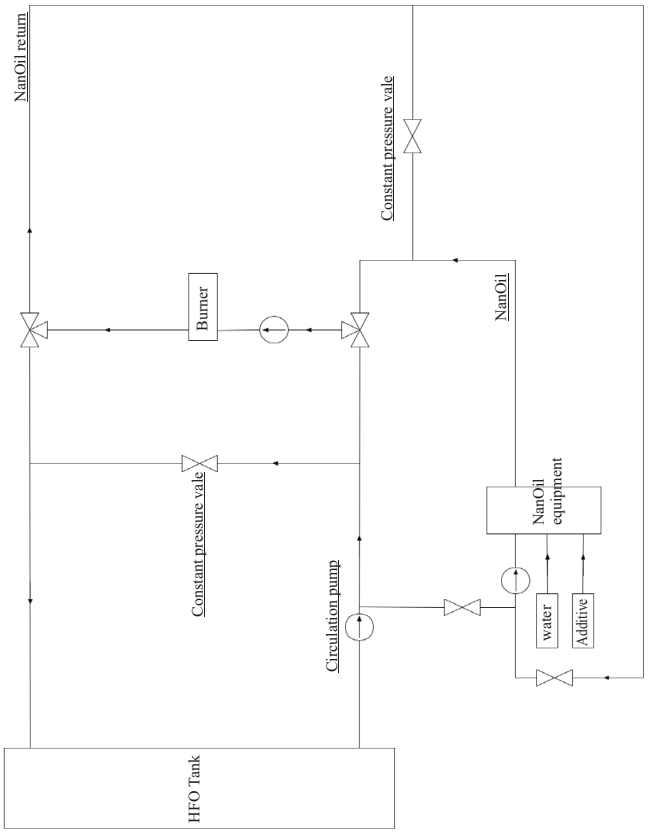
Technology

The NanOil system is capable of producing stable emulsions based on diesel based fuels such as regular diesel, kerosene, and all kinds of fuel oils. The emulsion fuel can be used in all current applications that use the feedstock fuels such as engines, burners, generators and boilers. The advantage of using emulsion fuel includes the following.

- Improved fuel economy
- Longer operating life of equipment
- Fewer emissions of harmful greenhouse gasses
- Reduced maintenance
- Fewer particulate emissions

The reason this works is because emulsion fuel takes advantage of secondary atomization inside the combustion chamber. What this means is basically that the water that has a lower boiling point (100°C) than the fuel, which is between 282°C and 338°C for regular diesel fuel. Because the combustion chamber in a regular diesel engine is around 2000°C the evaporation of the water manifests itself as a small explosion, resulting in a second atomization of the fuel inside the combustion chamber. The secondary atomization of the fuel creates a higher interfacial layer between the fuel and air, which results in better and more complete combustion.

Conceptual!P&ID!



The system is basically a scalable entity that consists of three input pipes representing the water, fuel and the chemical additive, which is mixed in our high-pressure, high-shear mixer into a stable fuel emulsion that can be used as a viable fuel source. The equipment is then installed in the current fuel system. To make the transition as easy as possible and to safeguard the production capability even during maintenance the system is installed in a "double-loop" so switching between emulsion fuel and regular feedstock fuel is as easy as turning a couple of valves. The following P&ID model represents a concept drawing of a NanOil system.

NanOil in limekiln burners

In relation to the use of NanOil emulsion fuel in large-scale limekiln burners as a process in paper production, the following will address the key issues in relation to this. These observations were made during our visit to the SPB facility, as mentioned in the introduction.

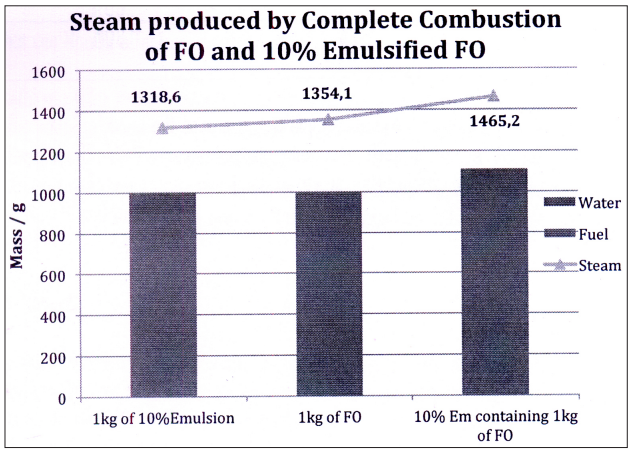
The main concerns when limestone is being processed into calcium oxide (CaO), is first and foremost temperature and moisture. The limestone must reach a temperature of at least 1100°C for the chemical reaction to happen and the final product must have very low moisture content. Besides the straight production of the limestone there are also a very important issue in the health of the refractory bricks inside the kiln. Should these bricks in any way be damaged it would require a complete shutdown of the entire production to change the damaged bricks. The main issues can therefore be defined in the following three areas.

- Temperature change when NanOil emulsion fuel is used in production
- Refractory brick integrity after emulsion fuel is introduced
- Moisture development inside the kiln during combustion of emulsion fuel

Because the flame characteristics change slightly when emulsion fuel is burned in stead of regular diesel or HFO fuel it is important to consider this when the fuel is introduced into the current system. One of these changes is that the water in the emulsion will cause the flame temperature to decrease slightly. This phenomenon is well known from current boiler applications where excess air is added during fuel injection into the combustion chamber. The temperature decrease caused by the water in the emulsion will be less than the temperature decrease seen with the addition of excess air, which means that this change can be offset with excess air trimming. It is furthermore possible to increase the fueling rate to offset the effects of the lower temperature the water causes when the emulsion fuel is combusted.

Because of the aforementioned changes in flame characteristics it is also important to note that the refractory bricks inside the kiln are of paramount importance for the production of CaO. Because the flame, when using emulsion fuel, will change its shape compared to a regular diesel- or heavy fuel it is important to make sure that there is no flame impinging on the side walls of the kiln. When emulsion fuel is used the flame will become slightly shorter and a little more "bushy", the degree to which this happens is basically down to the amount of water added into the fuel. The reason this happens can be explained by both faster carbon burnout rate and the secondary atomization's effect on combustion. By introducing the emulsion fuel incrementally NanOil will be able to control the changes and make sure that there is no adverse effect on the refractory bricks inside the kiln.

Finally the moisture development inside the kiln is important because the final product and the production time of the limestone is very closely related it is important that the lime-mud does not take on any extra moisture in the process. The only way this could happen is if the combustion of emulsion fuel will dramatically increase, and that the moisture from the combustion will have time to condense. Since the temperature in the kiln will never drop below 100°C. Furthermore we have proven that the increase in post combustion moisture when using emulsion fuel is only very slight, as depicted in the model underneath.



As the model shows the major component in the development of moisture in combustion is still provided by the fuel itself.

Results

NanOil has in a number of different applications been able to document not only massive improvements to the emissions of greenhouse gasses but also to the positive effects on fuel consumption when using emulsion fuels. For these reasons we feel are very confident in our technology and we will, based on the equipment age and condition, be able to live up to the following improvements.

	Min	Max
Direct fuel saving	2%	15%
Fuel to product (lime) ratio decrease	2%	15%
Decrease in NOx emissions	15%	60%
Particulate emissions decrease	20%	80%

Conclusion

Apart from these savings, using emulsion equipment will also decrease the need for kiln maintenance, because the combustion is much more complete and deposits inside the kiln will be drastically reduced. These things will in turn also ensure longer operating life of the equipment.