

ORIMULSION® FACT SHEET

Air Emissions Overview

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Orimulsion®, is a commercial boiler fuel presently used at power plants worldwide (e.g., Canada, Denmark, Japan, Italy, Lithuania, and China). This fuel is manufactured by PDVSA-BITOR from the vast bitumen reserves of the Orinoco Belt in Venezuela. Orimulsion® is a liquid fossil fuel made up of 70 percent bitumen, and 30 percent water. As with all fossil fuels, the combustion of Orimulsion® can result in the emissions of solid and gaseous air pollutants. This is a result of how the fuel is burned and the fuel characteristics. The emission characteristics of Orimulsion® are very similar to that of other fossil fuels, but in some areas Orimulsion® combustion produces lower emissions. Air pollutant control technology that is commonly available can limit emissions to levels considered "Best Available Control Technology," as defined by the United States Environmental Protection Agency.

Fuel Characteristics

Orimulsion® has similar chemical characteristics to other fossil fuels. It contains carbon and hydrogen, the major fuel energy components, as well as sulfur, ash and moisture. The combustible portion of Orimulsion® is very similar to that of No. 6 fuel oil as evidenced by the carbon to hydrogen ratio. The sulfur content of Orimulsion® is within the ranges of No. 6 fuel oil and coal. The ash content of Orimulsion® is slightly higher than fuel oil, but is much lower than coal.

| <u>Characteristics</u> | Characteristics of Fossil Fuels (% Wt) | | | |
|------------------------|---|-----------------------|-------------|--------------------|
| | <u>Orimulsion®</u> | <u>No. 6 Fuel Oil</u> | <u>Coal</u> | <u>Natural Gas</u> |
| Carbon (C) | 60.0 | 85.7 | 64.3 | 73.9 |
| Hydrogen (H) | 7.5 | 10.5 | 4.7 | 24.0 |
| C/H Ratio | 8.0 | 8.2 | 13.8 | 3.1 |
| Heat Content | 12,984 | 18,300 | 11,843 | 22,100 |
| Moisture | 29.5% | <1% | 5% | Negligible |
| Sulfur | 2.85% | 0.7 - 2.5% | <1 - 3% | <0.01% |
| Ash | 0.2% | 0.1% | 11.4% | Negligible |

Emission Characteristics

The combustion of fossil fuels can result in air pollutant emissions, even for fossil fuels such as natural gas that have low concentrations of impurities. A comparison showing the air pollutant emissions of various fossil fuels without applying controls is presented below. The table shows that the emission characteristics of Orimulsion® are within the ranges of most fossil fuels.

| <u>Pollutant</u> | Uncontrolled Emissions in Pounds per Million Btu | | | |
|------------------------------------|---|-----------------------|-------------|--------------------|
| | <u>Orimulsion®</u> | <u>No. 6 Fuel Oil</u> | <u>Coal</u> | <u>Natural Gas</u> |
| Particulate | 0.22 | 0.17 - 0.08 | 3.8 | <0.01 |
| Sulfur Dioxide (SO ₂) | 4.4 | 0.8 - 2.75 | 1.2 - 5.0 | <0.01 |
| Nitrogen Oxides (NO _x) | 0.51 | 0.77 | 0.7 - 1.4 | 0.55 |

Air Pollution Control

There are various types of control equipment that can reduce air pollutant emissions resulting from the combustion of fossil fuels. Many of these technologies are directly

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applicable to Orimulsion® and can reduce emissions by 90 percent or more. These technologies include electrostatic precipitators (ESP) and flue gas desulfurization (FGD) systems, common control systems for the reduction of particulate and sulfur dioxide emissions. Orimulsion® has relatively low emissions of NO_x due to the amount of water present in the fuel. The amount of water in Orimulsion® inherently lowers NO_x formed in the combustion process by lowering combustion temperatures. Nitrogen Oxides are formed at high combustion temperatures by reacting nitrogen (both atmospheric and fuel-bound) and oxygen. Lowering combustion temperatures concomitantly reduces the amount of NO_x formed.

The uncontrolled NO_x emissions from Orimulsion® are even low when compared to natural gas. For greater control, the use of low NO_x burners (LNB) and a control technology referred to as Reburn, have been demonstrated as viable control techniques for Orimulsion®. While direct application of these technologies is project specific, typical emission levels for Orimulsion® combustion, with state-of-the art technology, are shown in the table below.

| Control Technologies and Emissions in Pounds per Million Btu | | | | | |
|---|---------------------|-------------------|--------------------|------------------------------|-----------------------------|
| <u>Pollutant</u> | <u>Type Control</u> | <u>Efficiency</u> | <u>Orimulsion®</u> | <u>Coal-BACT^a</u> | <u>Fuel Oil^b</u> |
| Particulate | ESP | 94+% | <0.02 | <0.02 | 0.06 - 0.08 |
| Sulfur Dioxide | FGD | 95% | <0.25 | <0.3 | 1.1 - 2.75 |
| Nitrogen Oxides | LNB/Reburn | 60+% | <0.15 | <0.17 | 0.77 |

Notes: ^a - typical control levels for coal are: 99.5% for ESP, 90+% for FGD and Selective Catalytic Reduction (SCR) for NO_x control; ^b - fuel oil emissions without air pollution control equipment.

As shown, emissions from power plants using Orimulsion® are very similar to, or lower than, those for the most modern coal-fired power plants that have applied Best Available Control Technology (BACT) and are much lower than uncontrolled oil fired plants. Moreover, since Orimulsion® is a liquid fuel there are no emissions associated with fuel handling, unlike coal. Also, there are considerably lower amounts of ash (50 times less) using Orimulsion® than using coal.

For more information regarding Orimulsion®-400, please request additional Fact Sheets from:

| | |
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