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Expected start up emissions after catalyst system

This document provides engineering estimates on the start-up emissions for one Wärtsilä® 18V50SG B engine equipped with an efficient emission control system. The system includes a selective catalytic reduction system and an oxidation catalyst. The figures are best estimates only and shall not be considered as guarantee data.

The fast start-up of the engine results in varying exhaust gas flow, non-stable temperature, high and low range emission and oxygen levels which make accurate measurement and prediction of emissions very challenging. The flue gas emission estimates herein are based on emission measurement for steady conditions at different loads together with limited measurements performed during start-up. The data assumes that the engines will reach full load within 5 minutes.

The emission control performance in a start-up situation is based on catalyst supplier estimates as well as field and laboratory data. Collected data includes the uncontrolled and controlled emissions rates, mass flow rates, and temperatures for the catalyst elements as well as exhaust gas before and after catalyst elements, as a function of time.

From the temperature data, the elapsed time from engine start to when injection of urea/ammonia for NOx control can begin can be determined. Injection of urea/ammonia can only commence when the catalyst has reached high enough temperatures to allow NOx conversion, as well as preventing formation of ammonia salts on the catalyst face. The temperature profiles for the catalyst elements and exhaust gas also allow estimation of the catalyst reactivity and therefor conversion efficiency, for both the NOx and oxidation catalyst through the duration of start-up.

Based on the collected emissions, temperature and flow data, Wärtsilä has developed a simulation tool to calculate the expected emissions during start-up. This tool uses the vendor data on conversion efficiencies with temperatures and surface flow velocities to calculate expected emissions reductions in the exhaust gas. The results of these simulations were then compared to the tested controlled emissions rates, and the results of the two methods were found to be well correlated.

The estimated cumulative start up flue gas emissions with optimized reagent injection are expressed as lb per a start period (30 min) of one (1) Wärtsilä® 18V50SG B engine and are given for 3 different conditions in the table 1 below.

- Start 1: Cold start - A cold catalyst start is when the temperature of the catalyst material inside the reactor is close to ambient temperature. Cold catalyst starts are expected after over haul periods or when the engine has not been operated during the last 2-3 days.
- Start 2: Warm start – Restart after 6 h engine down time
- Start 3: Warm start - Restart after 12 h engine down time

The emission control system will reach its full abatement efficiency within 10-30 minutes from the start.

Table 1. Expected flue gas emissions during start up when using ammonia solution as reagent.

18V50SG-B	**Unit**	**NO_X (as NO_2)**	**CO**	**VOC (as CH_4)**	**PM10**	**CH_2O**
Start 1	lb/30 min	10.3	9.1	4.3	1.8	2.3
Start 2	lb/30 min	3.5	1.4	3.8	1.8	1.3
Start 3	lb/30 min	3.5	4.6	4.0	1.8	1.9

The VOC (volatile organic compounds) emissions depend on the composition of the fuel gas. The VOC emissions in table 1 above are based on max 0.50 vol-% VOC components in the feed fuel gas.

Stack emission measurements during start up sequences or heavy transient loads are by their nature transient conditions, and no EPA promulgated test methods are currently available for their measurements. The analyser response time for the gaseous emissions need to be fast enough. Moreover the particulate emissions will stay on a theoretical level since the particulates can not be determinate by an isokinetic sampling reference method.