



ANALYTICAL REPORT¹

ECO FXO INDUSTRIAL[®]

EFFECT OF THE ADDITIVE ON SO_x² EMISSIONS

ECO FXO INDUSTRIAL[®] additives are based on organic salts that are easily soluble in fuel. All research has been carried out in a way and with a goal to determine real effects of the additive **ECO FXO INDUSTRIAL[®]** in real working conditions.

Testing included:

1. Increase of the steam generator efficiency through a more complete combustion and reduction of deposits on heating surfaces.
2. Reduction of corrosion in the high-temperature areas by reducing the content and creation of vanadium compounds with a lower melting (bonding) temperature.
3. Reduction of corrosion in low-temperature areas by lowering the dew point of exhaust gasses, therefore reducing the possibility of appearance of condensed sulphuric acid.

Total amount of created sulphur oxides (SO₂+SO₃) depends on the content of sulphur in the fuel, and therefore the additive cannot have any effect on that. The content of sulphur dioxide (SO₂) which turns into sulphur trioxide (SO₃) through further oxidation depends on several influential factors:

- Surplus of oxygen in exhaust gasses
- Presence of iron oxide (from corrosion Fe₂O₃)
- Presence of vanadium oxide (V₂O₅)

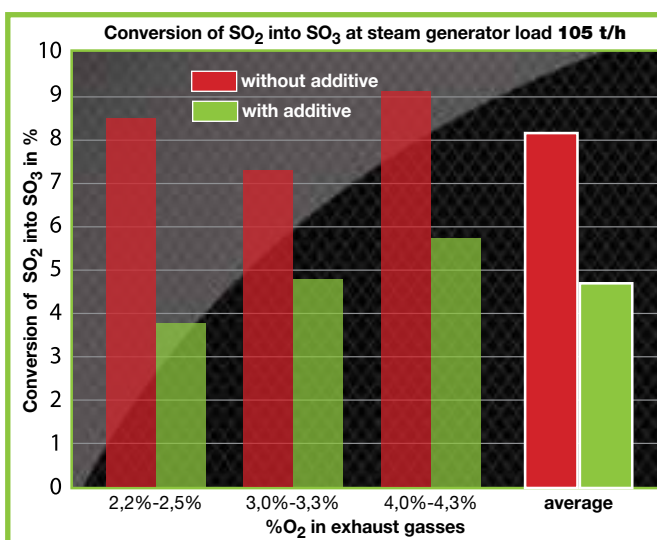
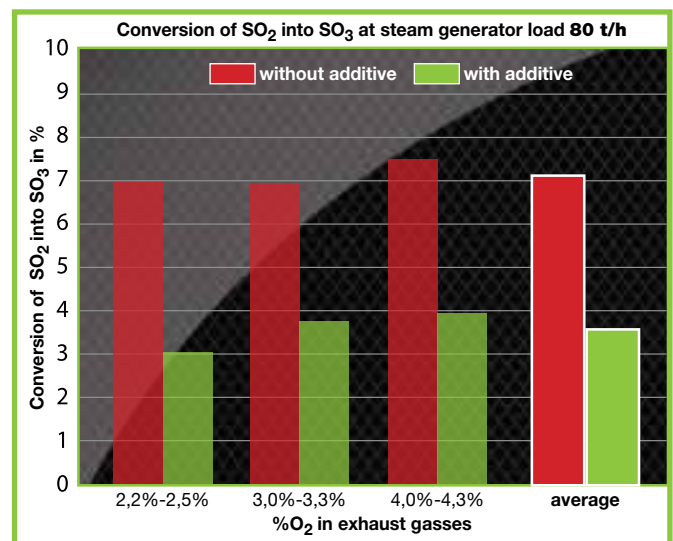
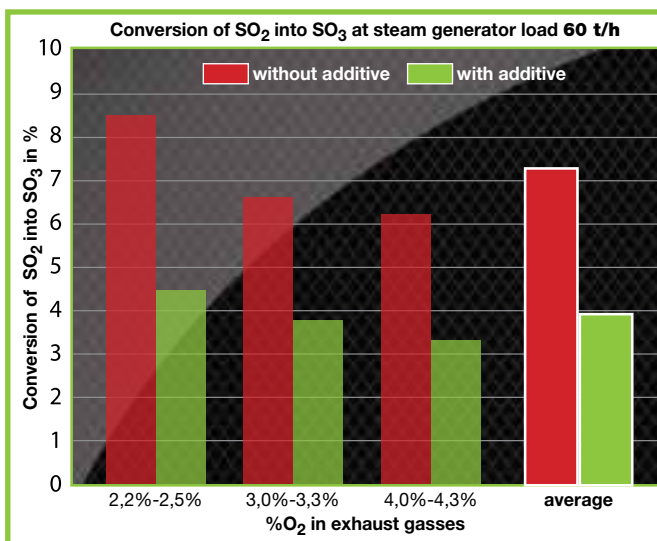
If the sulphur dioxide (SO₂) from exhaust gasses comes into contact with iron or vanadium oxide while passing over heated surfaces containing such sediments, and if such exhaust gasses contain a surplus of unspent (free) oxygen, this creates conditions which at temperatures of 500 to 600°C favor creation of sulphur trioxide (SO₃).

1) Complete data on analytical reports are available at the FLEX-O ECO d.o.o. company
2) Used materials are a work of prof.dr.sc. Zmagoslav Prelec and associates.

In almost every steam generator that burns fuel with sulphur content, a certain amount of sulphur trioxide (SO₃) appears. While sulphur dioxide (SO₂) does not have any significant effect on the work (availability) of the steam generator, but only on the emissions into the environment, sulphur trioxide (SO₃) has a significant effect on the availability of steam generators due to its direct influence on low level corrosion that appears on “colder” surfaces of the steam generator.

Low temperature corrosion appears in conditions when sulphuric acid (H₂SO₄) condensates from sulphur trioxide (SO₃) and water steam (H₂O). In fact, if there are parts (heating surfaces) within the generator with a temperature lower than the dew point (condensation) of water steam, conditions appear for the condensation of sulphuric acid, and thus a very intensive corrosion. With a higher sulphur trioxide (SO₃) content in exhaust gasses and a higher dew point, the corrosion becomes more intensive.

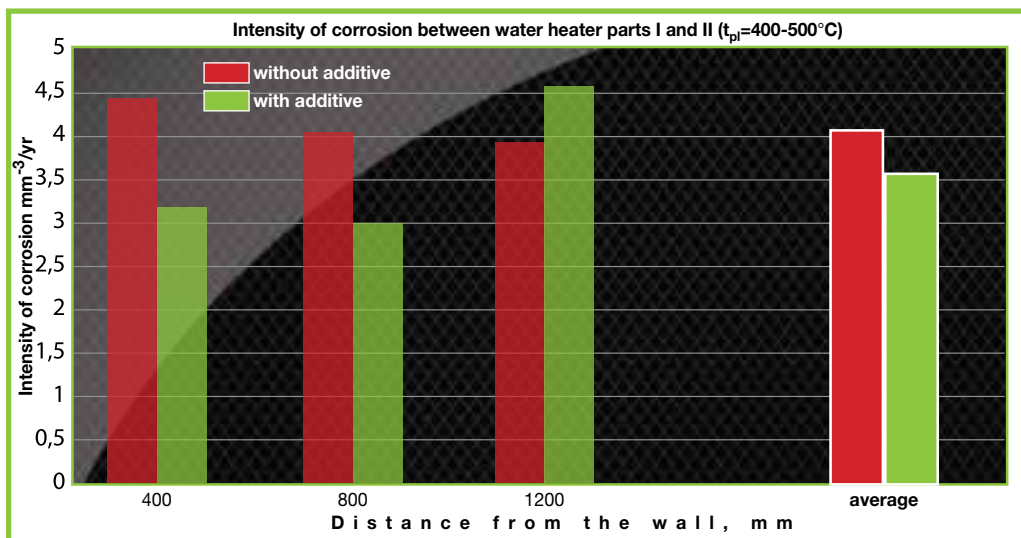
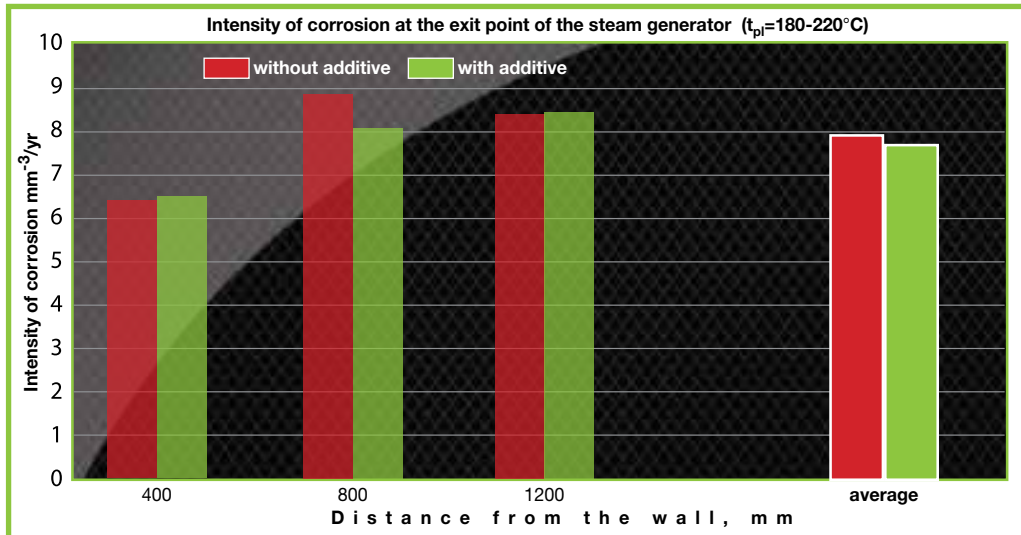
The following graphs show a decrease with additive use:



Based on these results, the conclusion is:

1. Generator load has no significant influence on the amount of SO₃ in exhaust gasses or on the share of conversion of SO₂ into SO₃.
2. Change of surplus air for combustion in the tested span does not show significant influence on conversion of SO₂ into SO₃.
3. Testing results of drive states with the additive for light distillate oil show a reduction in conversion of SO₂ into SO₃ in the amount of 40 – 50%
4. Dew point for exhaust gasses has been lowered by about 7°C.

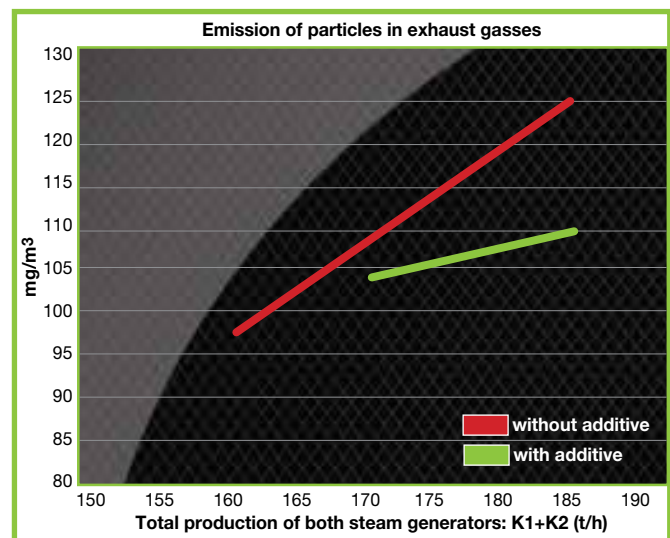
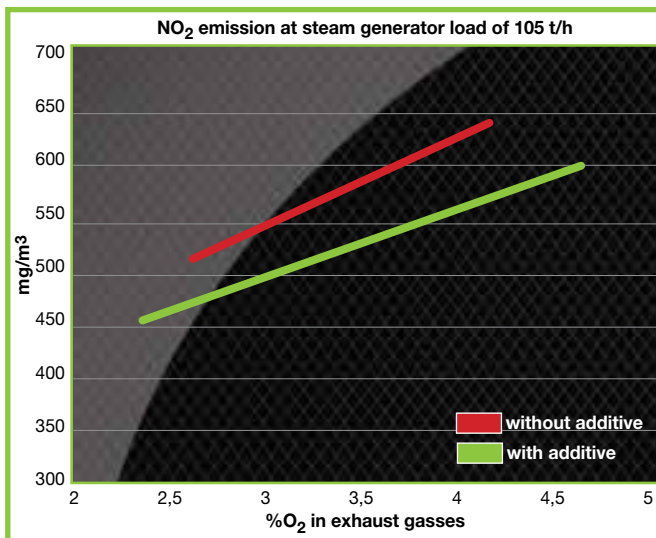
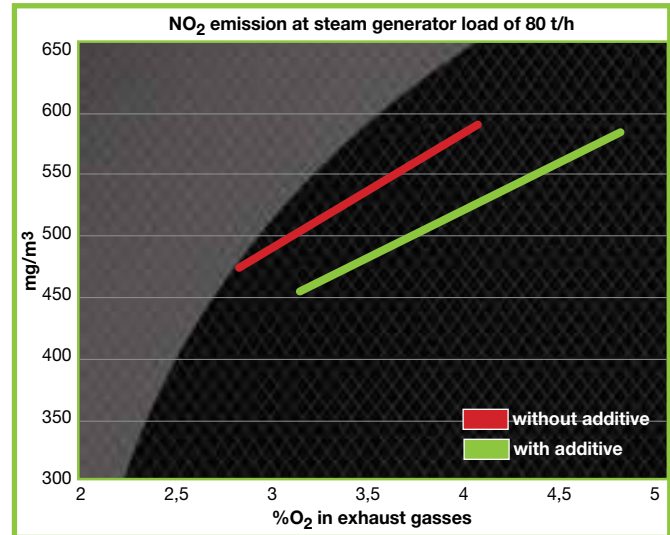
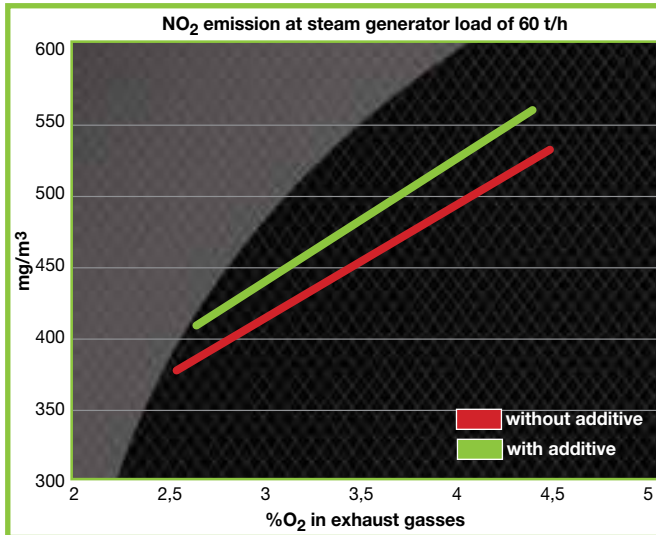
INFLUENCE OF THE ADDITIVE ON THE INTENSITY OF CORROSION



In the area of exit temperatures of exhaust gasses ($180-220^{\circ}\text{C}$) a relatively high intensity of corrosion has been determined, on average about 0.30 to 0.45 mm/yr.⁴ Average intensity of corrosion with the additive, determined based on measurements in the $400-500^{\circ}\text{C}$ temperature area in three positions, is 12% less than the state without used additives.

⁴ Detailed measurements can be found in the original study.

INFLUENCE OF THE ADDITIVE ON EMISSIONS IN EXHAUST GASSES



Based on the obtained results, the conclusion is:

1. Emission of nitrogen oxides (NO_x) increases with the steam generator load, as well as with an increase of surplus air for combustion.
2. Testing under load of 60 t/h shows smaller NO_x emissions in conditions without additives. These differences are about 10%.
3. Nitrogen (N) content in fuel has a strong influence on emissions.
4. Results show a smaller emission of particles in conditions where additives were added in areas of greater steam generator loads (above 80 t/h).
5. Measured emissions of nitrogen oxide (NO_x) and particles are smaller than valid limit values for emissions (GVE) by about 10%. However, these emissions are greater than limit values for emissions (GVE) which were introduced in our country in 2009.