

## Application Note

### XMAN-10A.V1

# X-MET5000 / 5100 - Flow Accelerated Corrosion Report

FAC (Flow Accelerated Corrosion), sometimes called flow assisted corrosion, is a type of corrosion where the protective oxide layer ( $\text{Fe}_3\text{O}_4$ ) is removed from piping material by flow, typically flowing water and/or steam. This process occurs slowly over many years and the end results are thinned pipe walls and components. The thinning walls can result in catastrophic failure with little or no warning. This problem is well known in nuclear and fossil fuel power plants. Maximum corrosion rates occur in the temperature range of 130-180°C (265-355K). In the pulp & paper industry this is the typical operation range of deaerators.

Boiler systems in power plants are usually fabricated from heat resistant carbon steel like A106 in US or St.44.0 used in Europe. Typical chromium (Cr) concentrations in these alloys are below 0.1%. However, based on the ASME specification, Cr content can vary from 0% to 0.4%. If Cr content is below 0.05%, flow accelerated corrosion occurs significantly faster. Copper (Cu) and molybdenum (Mo) are added to prevent FAC. Elemental composition is not the only factor effecting FAC. Other factors include the piping geometry, the amount of dissolved oxygen in the water, the flow rate and the chemistry and pH of flow material.

Traditionally, optical emission spectroscopy has been used for this application. Recent developments in X-ray fluorescence (XRF) technology now permit the use of handheld XRF instruments to measure FAC. However, the low concentration levels of Cr typically demand long measurement times in the range of 1-2 minutes. With the Oxford Instruments X-MET5000 or new X-MET5100, measurements can be made much faster without compromising accuracy.

The results below are taken using both X-MET5000 and X-MET5100 with a 60 second measurement time. It is clear that both X-MET5000 and X-MET5100 can easily detect low Cr levels to identify potential corrosion hazards. The new, high performance Oxford Instruments silicon drift detector (SDD) in the X-MET 5100 offers improved detection limit and precision compared to the X-MET5000 at the same measurement time, or equivalent performance at shorter measurement times. The accuracy of the Cr readings obtained with both X-MET models is similar to that obtained using a laboratory instrument, which is remarkable since the X-MET is a hand-held XRF unit.

**X-MET5000**

Method: FAC (Flow Accelerated Corrosion)			
Type: Empirical Chemistry			
Time: 60 seconds			
Units: Percent			
Alloy: C-1008			
Element	Cr	Cu	Mo
Run 1	0,022	0,018	0,002
Run 2	0,015	0,006	0,007
Run 3	0,019	0,022	0,005
Run 4	0,027	0,014	0,007
Run 5	0,007	0,013	0,004
Run 6	0,01	0,022	0,013
Run 7	0,021	0,022	0,008
Run 8	0,01	0,028	0,006
Run 9	0,021	0,023	0,007
<b>Average</b>	<b>0,017</b>	<b>0,019</b>	<b>0,007</b>
STDEV	0,007	0,007	0,003
Certified Value	0,020	0,015	0,007

**X-MET5100**

Method: FAC (Flow Accelerated Corrosion)			
Type: Empirical Chemistry			
Time: 60 seconds			
Units: Percent			
Alloy: C-1008			
Element	Cr	Cu	Mo
Run 1	0,022	0,015	0,008
Run 2	0,022	0,018	0,009
Run 3	0,018	0,013	0,009
Run 4	0,017	0,016	0,008
Run 5	0,019	0,016	0,008
Run 6	0,021	0,017	0,009
Run 7	0,018	0,016	0,008
Run 8	0,02	0,017	0,009
Run 9	0,021	0,017	0,008
<b>Average</b>	<b>0,020</b>	<b>0,016</b>	<b>0,008</b>
STDEV	0,002	0,001	0,001
Certified Value	0,020	0,015	0,007

Method: FAC (Flow Accelerated Corrosion)			
Type: Empirical Chemistry			
Time: 60 seconds			
Units: Percent			
Alloy: C-1522			
Element	Cr	Cu	Mo
Run 1	0,076	0,06	0,027
Run 2	0,083	0,046	0,025
Run 3	0,087	0,059	0,024
Run 4	0,08	0,055	0,022
Run 5	0,075	0,059	0,028
Run 6	0,076	0,048	0,023
Run 7	0,082	0,059	0,022
Run 8	0,08	0,054	0,022
Run 9	0,074	0,046	0,024
<b>Average</b>	<b>0,079</b>	<b>0,054</b>	<b>0,024</b>
STDEV	0,004	0,006	0,002
Certified Value	0,077	0,060	0,026

Method: FAC (Flow Accelerated Corrosion)			
Type: Empirical Chemistry			
Time: 60 seconds			
Units: Percent			
Alloy: C-1522			
Element	Cr	Cu	Mo
Run 1	0,079	0,058	0,023
Run 2	0,077	0,061	0,025
Run 3	0,074	0,055	0,025
Run 4	0,074	0,058	0,024
Run 5	0,073	0,061	0,026
Run 6	0,074	0,057	0,024
Run 7	0,073	0,058	0,024
Run 8	0,078	0,062	0,026
Run 9	0,07	0,059	0,026
<b>Average</b>	<b>0,075</b>	<b>0,059</b>	<b>0,025</b>
STDEV	0,003	0,002	0,001
Certified Value	0,077	0,060	0,026

**X-MET5000**

Overall Performance Results			
	Cr	Cu	Mo
Cal Range Min	0	0	0
Cal Range Max	0,5	0,24	0,22
Average Error	0,005	0,005	0,003
Max Error	0,008	0,011	0,005
Detection limit, 60s	0,028	0,03	0,012

**X-MET5100**

Overall Performance Results			
	Cr	Cu	Mo
Cal Range Min	0	0	0
Cal Range Max	0,5	0,24	0,22
Average Error	0,002	0,002	0,001
Max Error	0,005	0,008	0,003
Detection limit, 60s	0,006	0,003	0,002

**Instrument specification**

X-MET5000 analyser or X-MET5100 with FAC calibration option (Part Number: 3062882C)