

Flammability Testing for Heavy Oil Mists

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Introduction

- High flashpoint fluids used in industry for various reasons such as heating, power generation, lubrication, hydraulics
- Often considered to be 'non-hazardous' with regards to DSEAR/ATEX
- However, if released under pressure through small orifice flammable mist may be generated

Existing Guidance & Experimental Research

- Guidance provided in *Model code of safe practice Part 15 (EI15)* and *RR1107 Area classification for oil mists – final report*
- EI15 suggests “a few bar” of pressure may be sufficient to potentially generate a flammable mist – Table C4 provides HAC guidance
- RR1107 provides guidance on credibility of mist generation based on fuel properties and release characteristics



On-site Application

- Large power station client located in UK
- Heavy oil (Class G - BS 2869) used on-site as a fuel oil for boilers
- Varying flash point between 66 °C and 125°C
- Fuel distributed at up to 40 barg and 130 °C
- Current Hazardous Area Classification based on EI15 resulting in hazardous area extents of up to 3m

Conducted Flammability Tests

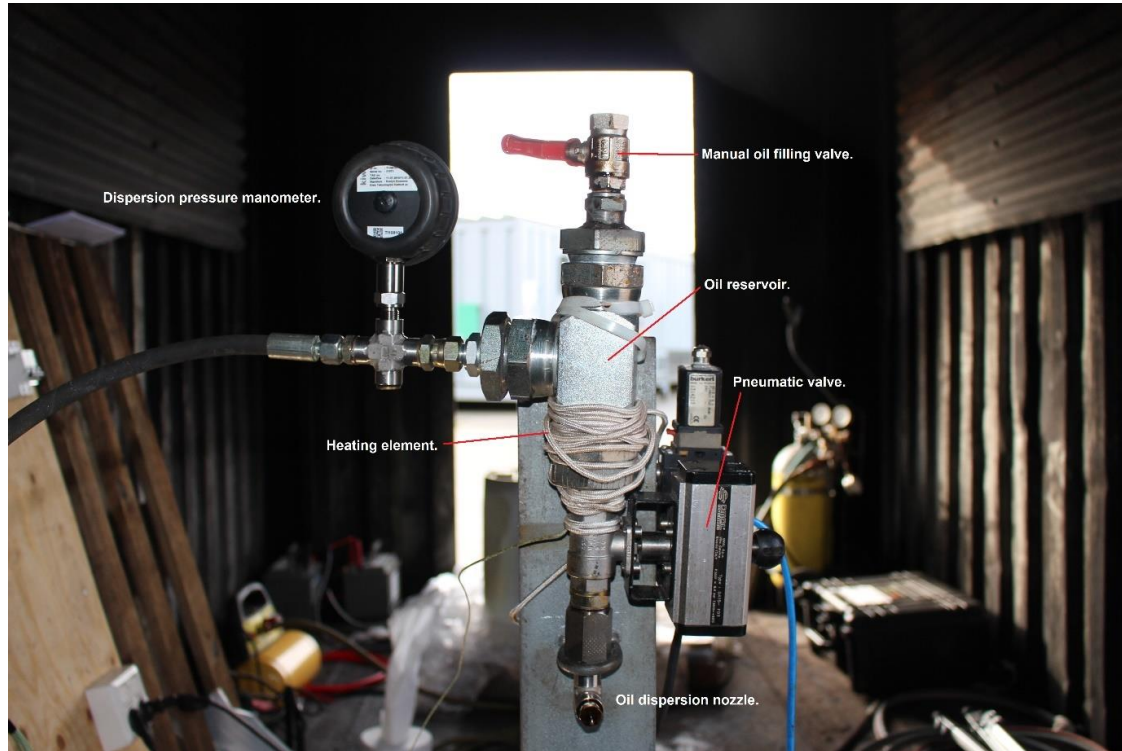
- Free jet experiments – spray into open surrounding

Pressure (barg)	Temperature (°C)
Max	Max
1.2	60
20	145
50	145

- Closed chamber experiments – influence of impingement

Pressure (barg)	Temperature (°C)
Max	Max
1	145
4	145
7	145

Free Jet Experiments – Test Setup



Free Jet Experiments – Video



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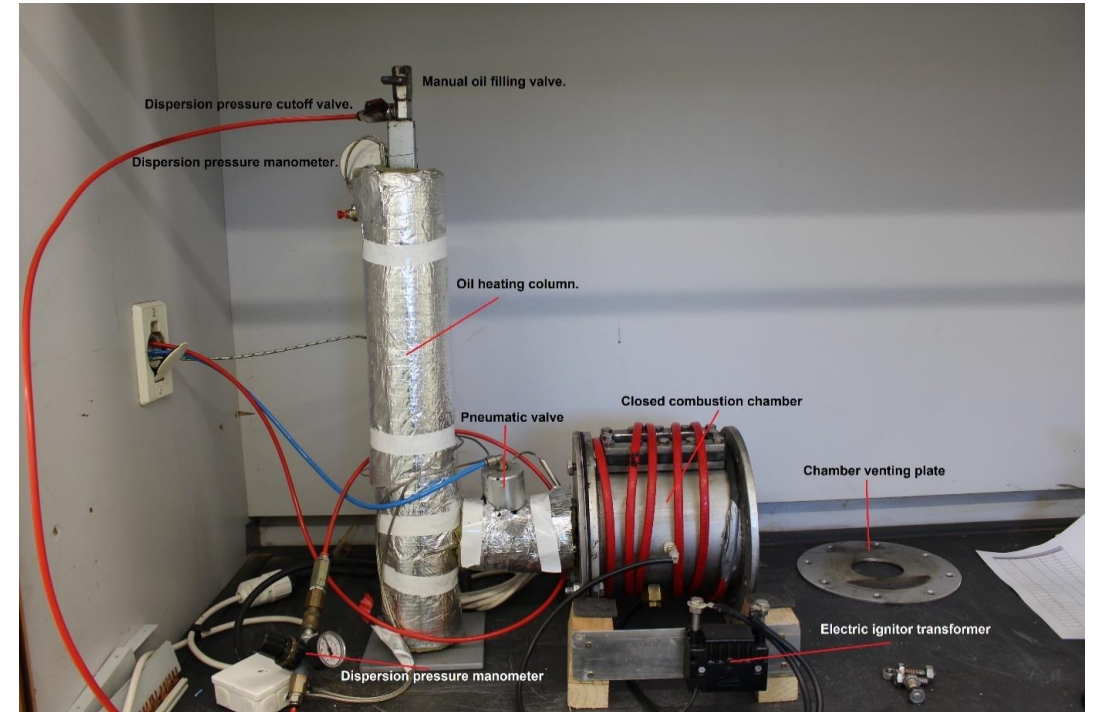
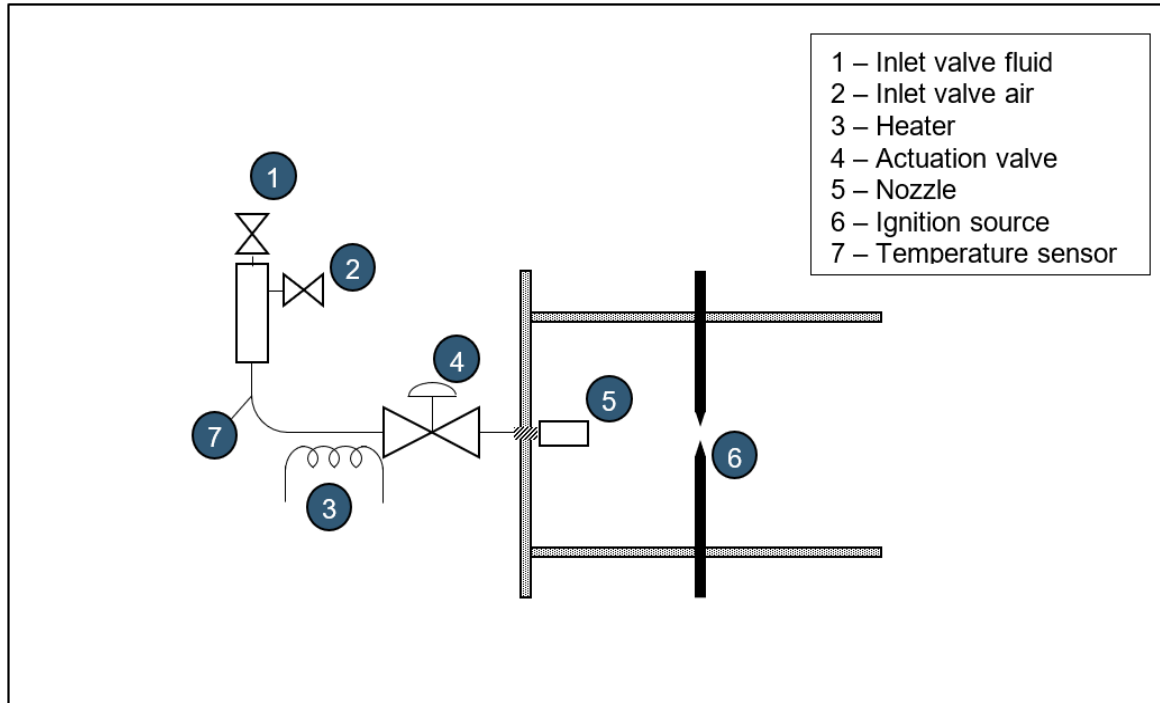
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Free Jet Experiments – Test Results

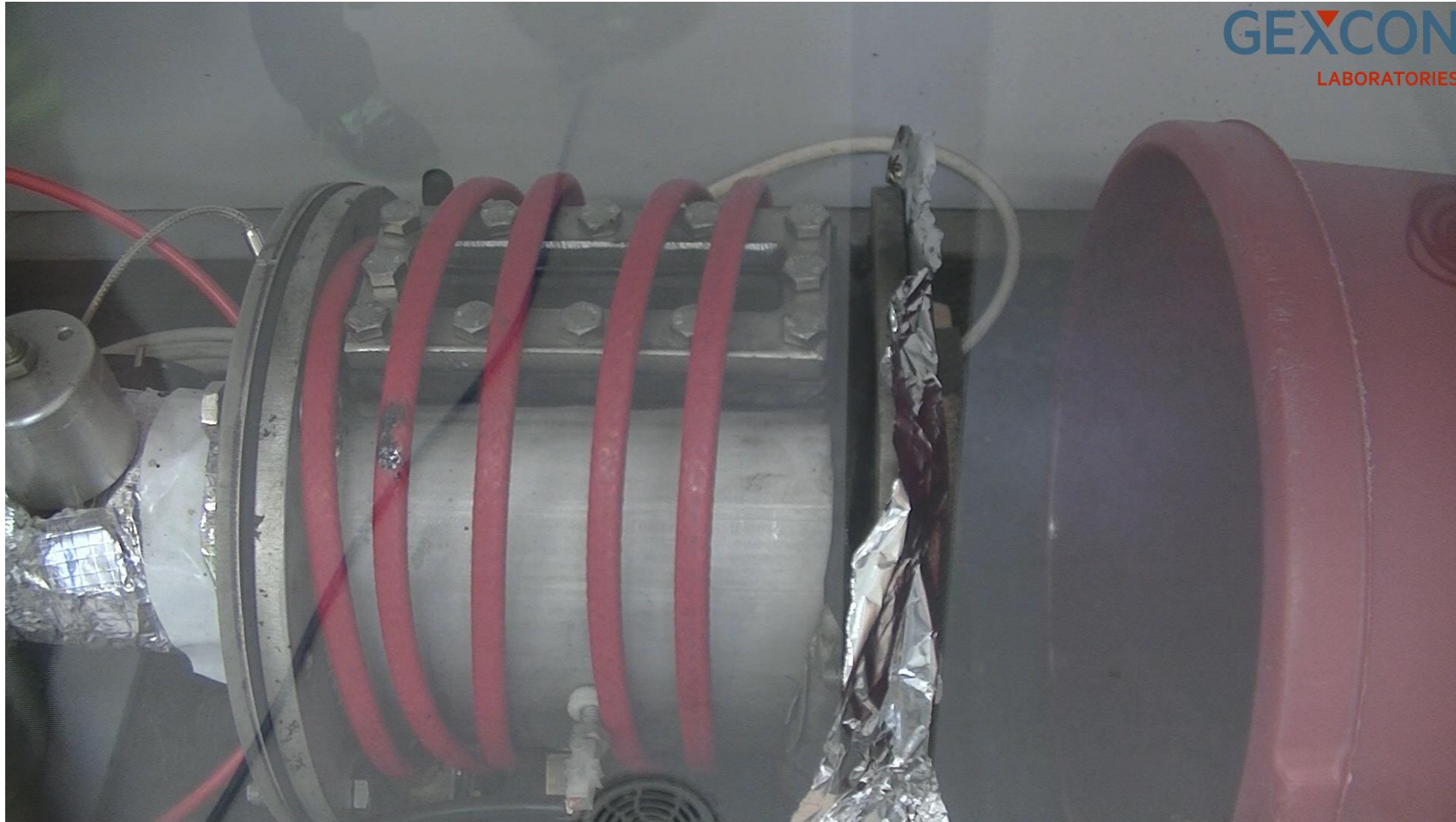
Pressure (barg)	Temperature (°C)	Maximum Consistent Ignition Distance	Maximum Ignition Distance	Minimum No-Ignition Distance
1.2	65	No ignitions or mist generation.	No ignitions or mist generation.	No ignitions or mist generation.
1.2	145	No ignitions or mist generation.	No ignitions or mist generation.	No ignitions or mist generation.
20	145	0.75 meters.	1.0 meters. 6 ignitions out of 10.	1.25 meters.
50	145	1.75 meters.	2.0 meters. 5 ignitions out of 8.	2.25 meters.

Experimental results using a 1 mm nozzle

Closed Chamber Experiments – Test Setup



Closed Chamber Experiments – Video



Closed Chamber Experiments – Test Results

Pressure (barg)	Temperature (C)	Ignition? (yes/no)
1	65	No, and no dispersion of oil
4	65	Yes
7	65	Yes
1	100	Yes
4	100	Yes
7	100	Yes
1	145	Yes
4	145	Yes
7	145	Yes

- Influence of impingement on likelihood of generating flammable mist demonstrated

Experimental Results vs. HAC Guidance

#Ref Test Conditions	Test Conditions	Guidance HAC distance [m]	Ignition	Maximum Ignition Distance [m]	Comment
1	Free Jet – 1.2 barg / 65°C / 1mm nozzle	Non-hazardous	No	N/A	Based on RR1107, for Release-Class II
2	Free Jet – 1.2 barg / 145°C / 1mm nozzle	2	No	N/A	Based on EI15 Table C4 R ₁ for Fluid Category C / 5 barA
3	Free Jet – 20 barg / 145°C / 1mm nozzle	2.5	Yes	1	Based on EI15 Table C4 R ₁ for Fluid Category C / 50 barA
4	Free Jet – 50 barg / 145°C / 1mm nozzle	2.5	Yes	2	Based on EI15 Table C4 R ₁ for Fluid Category C / 50 barA
8	Free Jet – 1.2 barg / 65°C / 2mm nozzle	Non-hazardous	No	N/A	Based on RR1107, for Release-Class II
10	Free Jet – 50 barg / 145°C / 2mm nozzle	5	No	N/A	Based on EI15 Table C4 R ₁ for Fluid Category C / 50 barA and 2mm release hole diameter
11	Closed Chamber – 1 barg / 65°C / 0.5mm nozzle	2	No	N/A	Based on EI15 Table C4 R ₁ for Fluid Category C / 5 barA and 1mm release hole diameter
12	Closed Chamber – 4 barg / 65°C / 0.5mm nozzle	2	Yes	N/A	Based on EI15 Table C4 R ₁ for Fluid Category C / 5 barA and 1mm release hole diameter

Conclusion

- Experimental tests on generation of flammable mists appear to indicate that current guidance is conservative for specific test scenarios
- Maximum ignition distance consistently below hazardous distance according to current guidance
- Limited scope of experiments do not allow general conclusion on conservatism of current guidance – further experimental research would be required
- In specific case client did not change hazardous area classification on-site due to limited difference between existing guidance and experimental test results

Thank you for your attention.

Any questions?

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