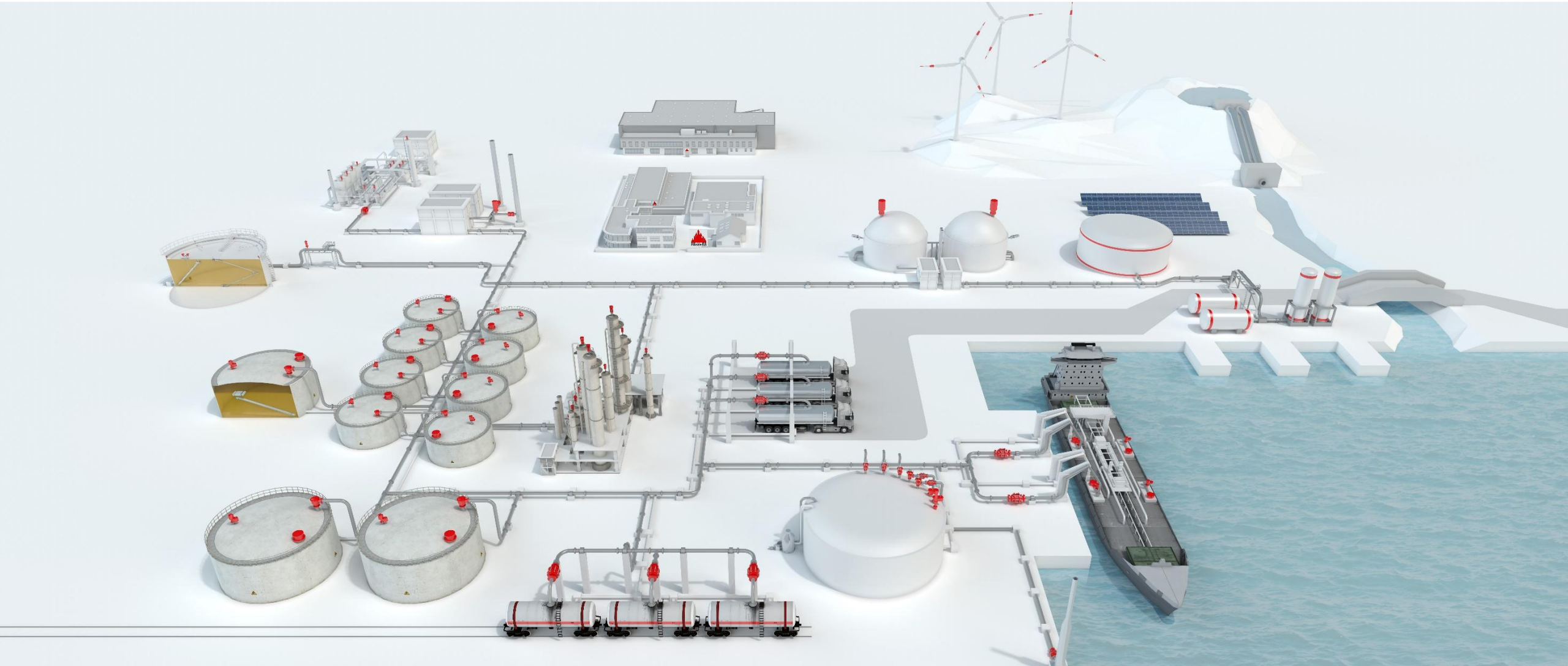
PROTEGO® - Excellence in Safety and Environment

Flame Arresters Technology and Maintenance

Dr. Michael Davies, Hussam Al-Qahtani, Dr. Thomas Hembach 08/10/2025



Flame Arrester Basics

A device fitted to the opening of an enclosure or to the connecting pipe work of a system of enclosures and whose intended function is to allow flow but prevent transmission of flame.

Protected side

Unprotected side

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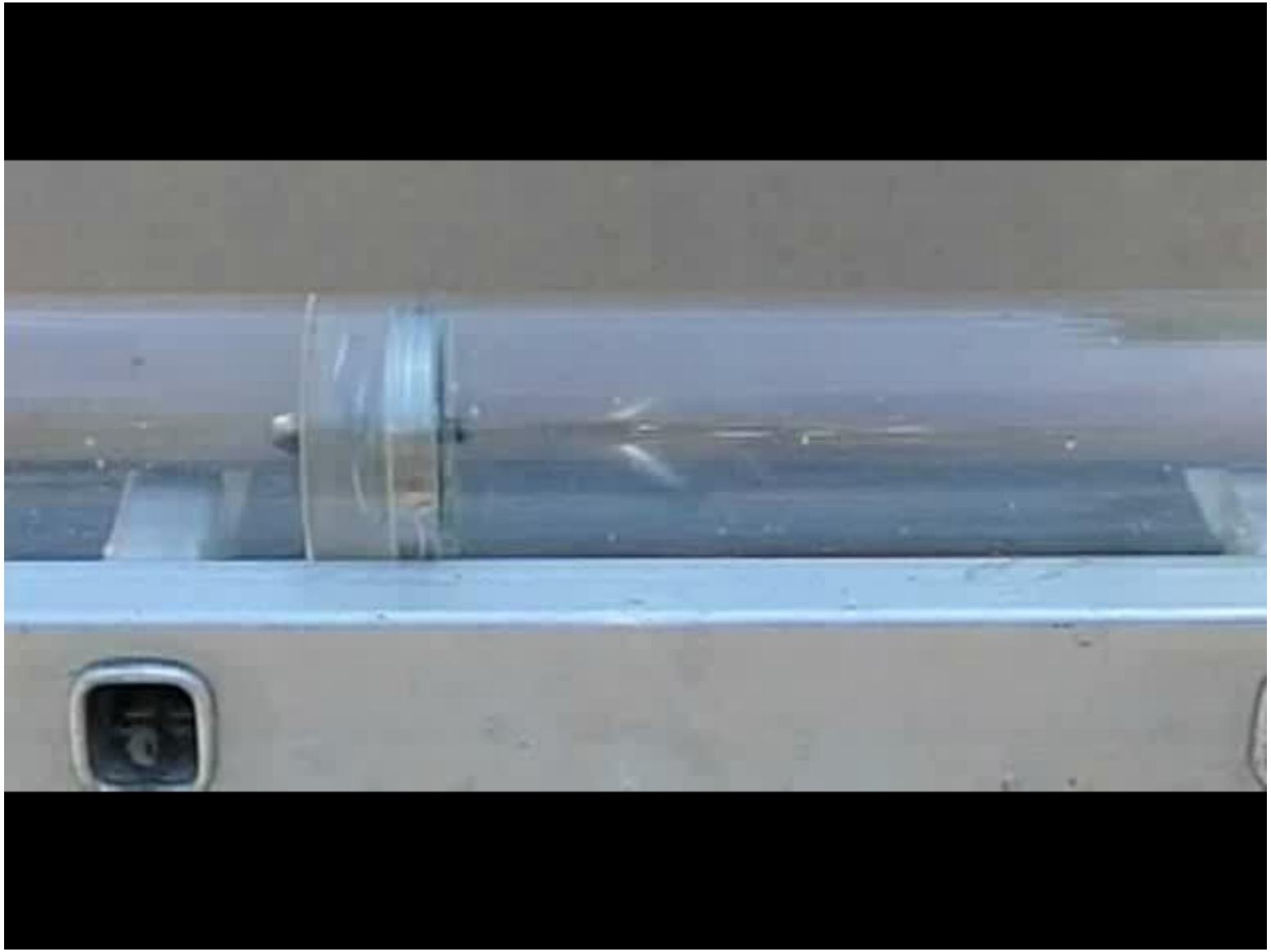
Stopping Flame Propagation



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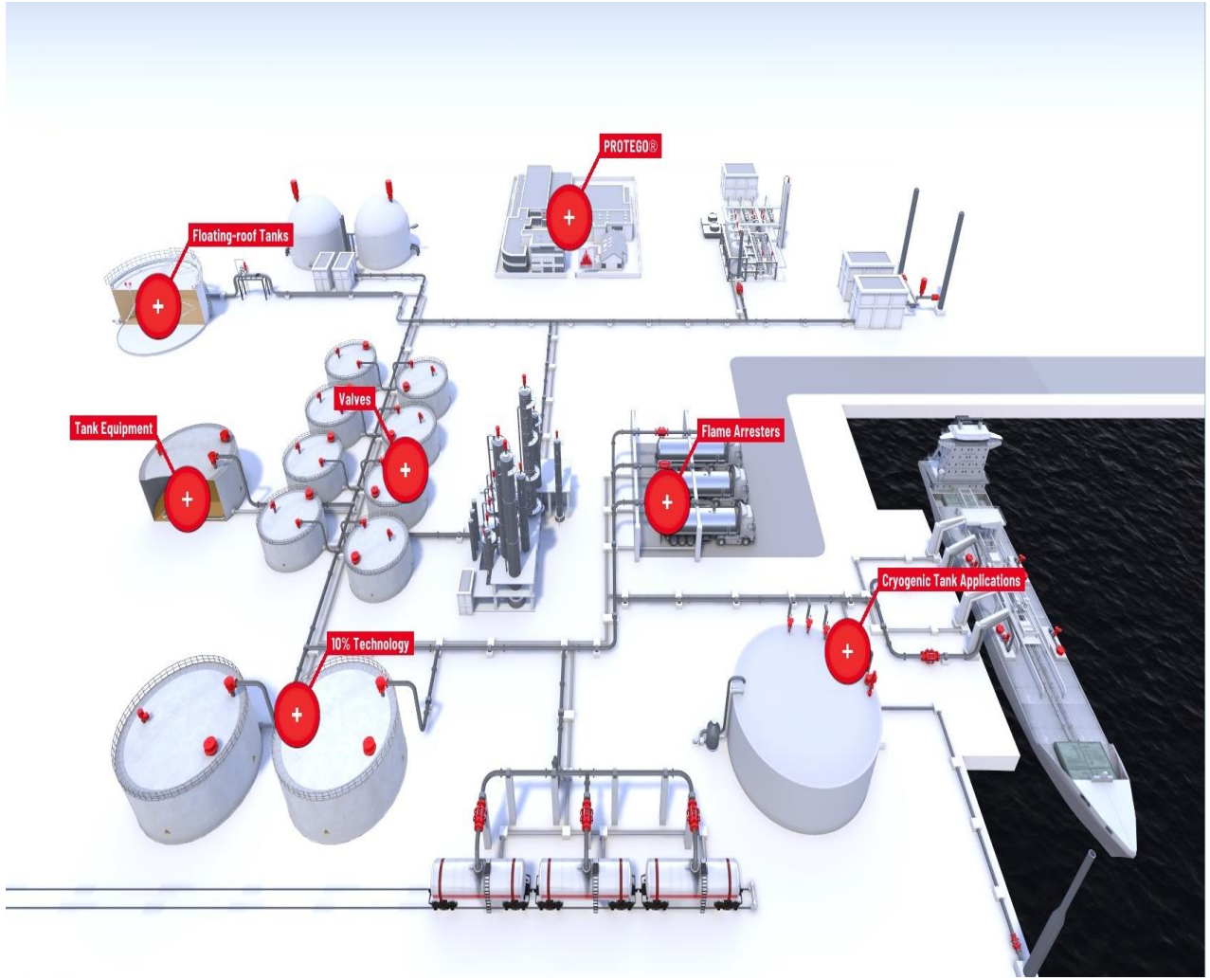
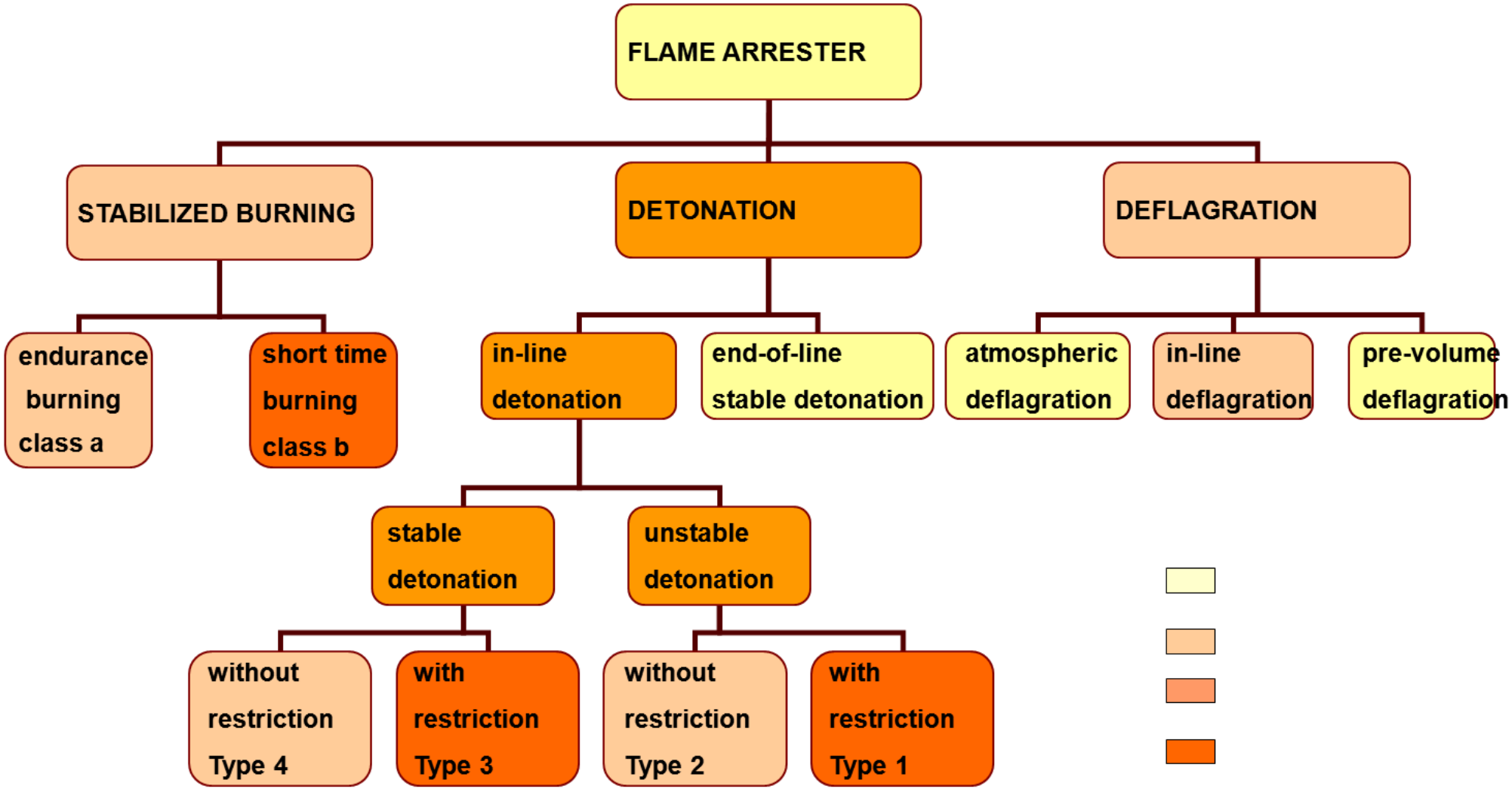
Flame Arrester Applications – Why do we need them?



- Storage Tanks / Tank Farms
- Process Equipment
- Vapor Combustors / Flares
- Ship Loading Systems
- Vapor Recovery Units
- Specialized equipment (ex. blowers)

International Standard ISO 16852



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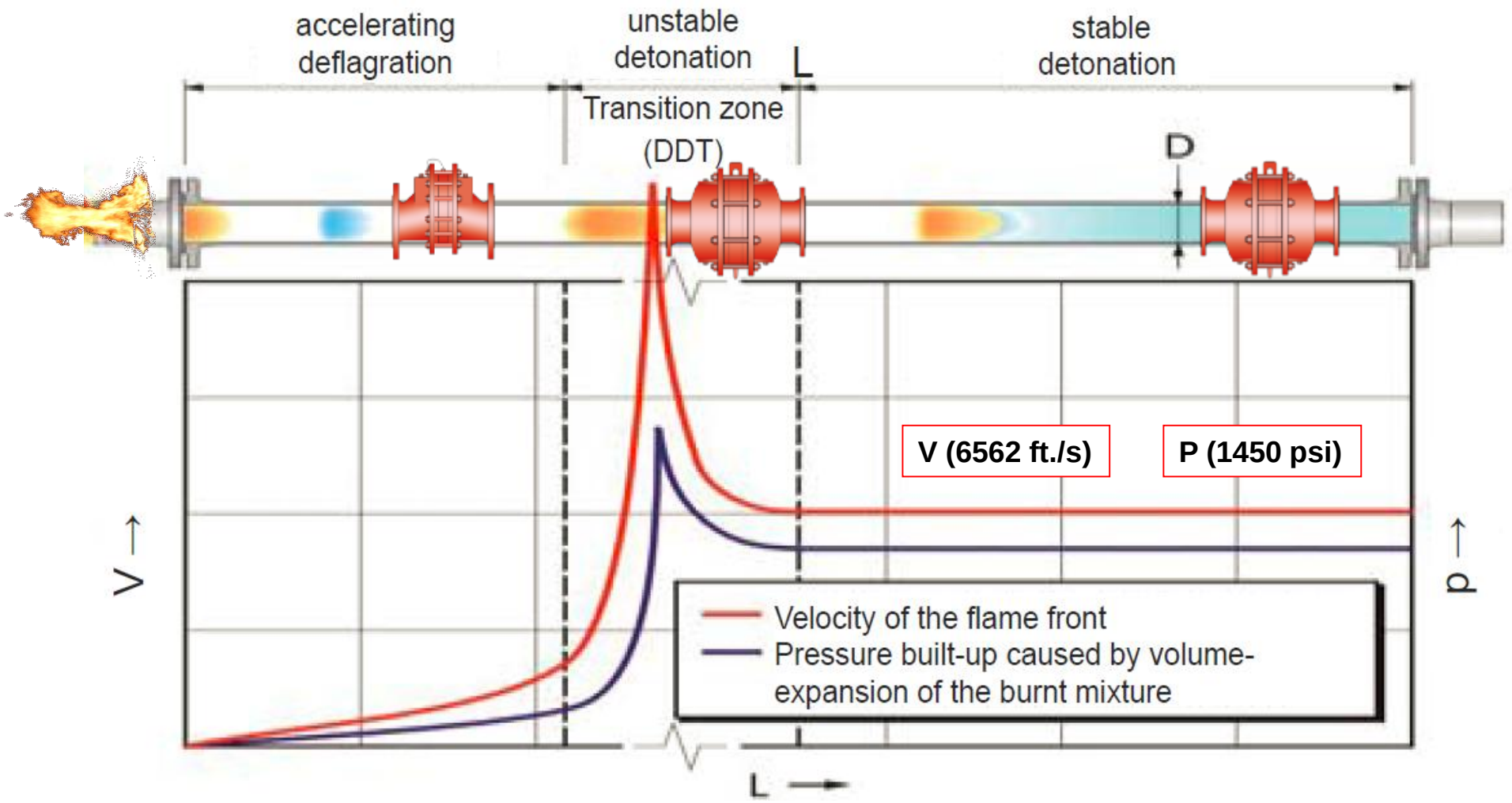
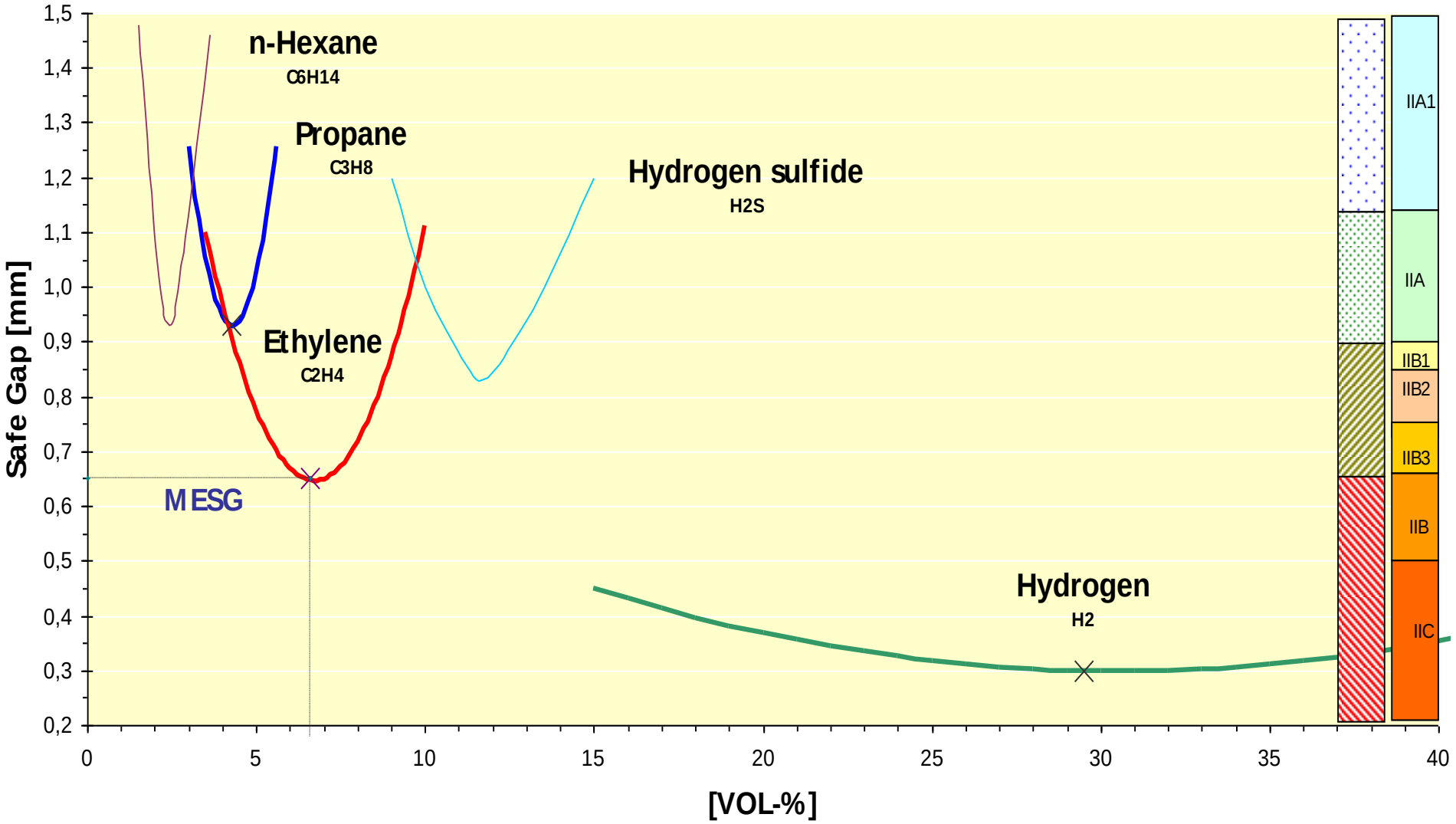
Example of a detonation propagating through a pipe

In Line Deflagration, Unstable & Stable Detonation



MAXIMUM EXPERIMENTAL SAFE GAP



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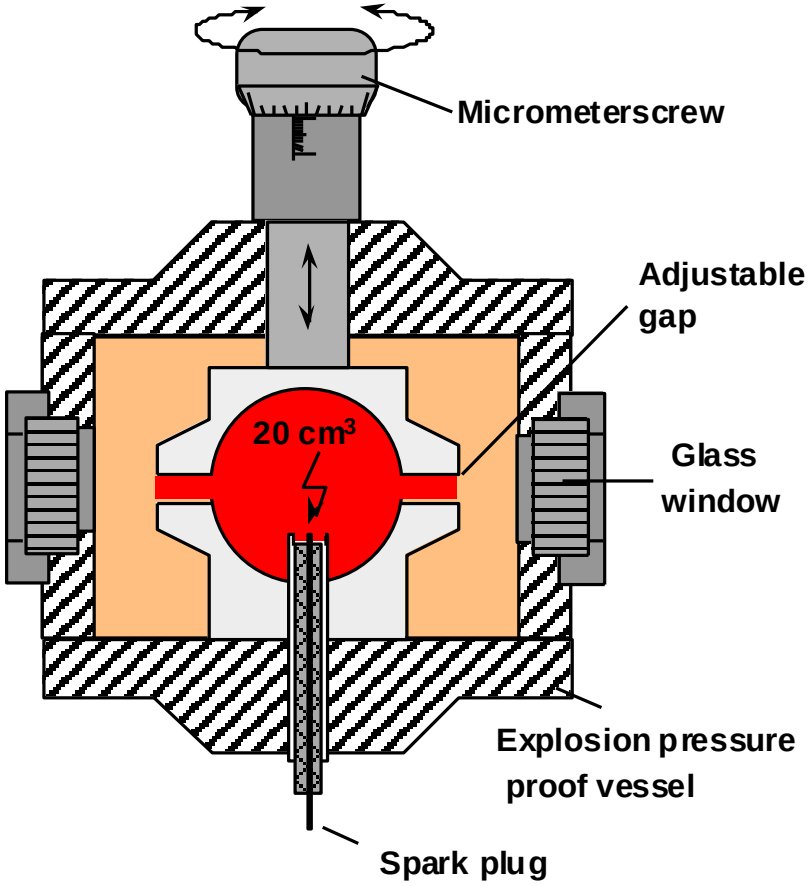
Critical Factor: MESG Value



Substance	MIE (mJ)	MESG (mm)	
Carbon-disulphide	0,009	0,34	II C
Hyrdogene	0,016	0,29	
Acetylene	0,019	0,37	
Ethylene	0,082	0,65	II B
Diethylether	0,19	0,87	
n-Propanol		0,87	
Methane	0,28	1,14	II A
Propane	0,25	0,92	
n-Butane	0,25	0,98	
n-Hexane	0,24	0,93	
n-Heptane	0,24	0,91	
Methanol	0,14	0,92	
Ammonia	14,0	3,17	

PTB

Principle of MESG apparatus

3.3

© 2002 PTB 3.33

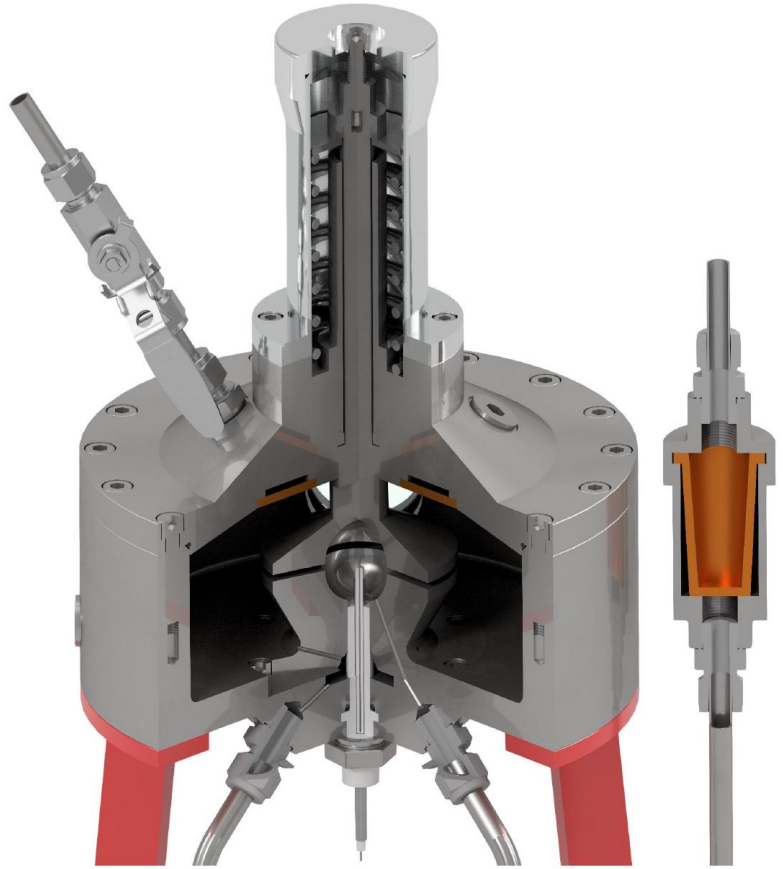


Fig. 3: Sectional model of the MESG-device.

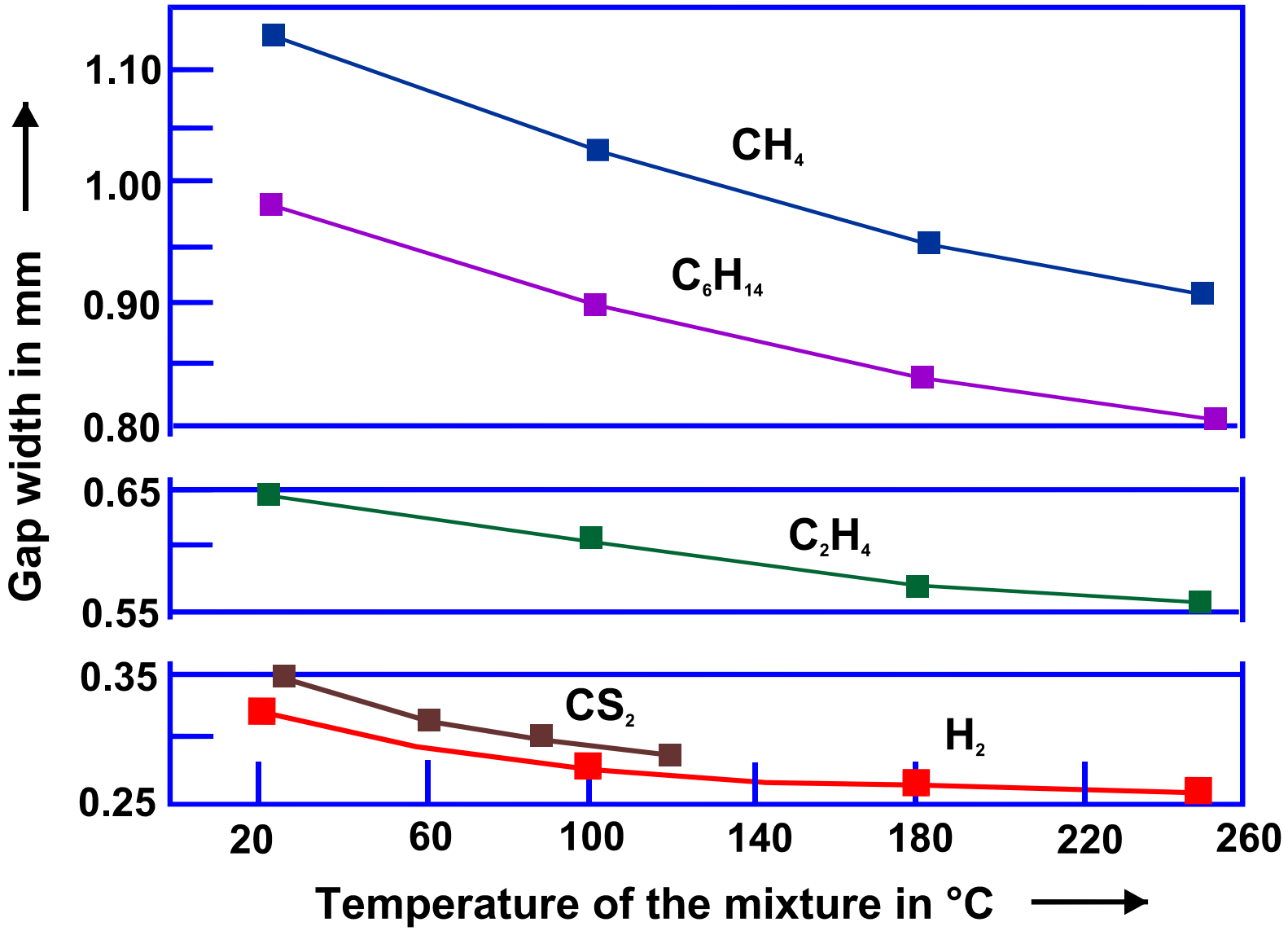
Conservation Vents & Flame Arresters

In-Line Deflagration

DN 1000

6,6 vol% Ethylene in Air

Critical Factor: Process Temperature



Critical Factor: Process Temperature

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Layer of Protection Concept (ISO 16852, NFPA 69, PD CEN/TR 16793:2016)

When designing overall safety concepts one has to take account of:

- The likelihood of adverse events (e.g. flame transmission from ignition source)
- The extent of the consequences

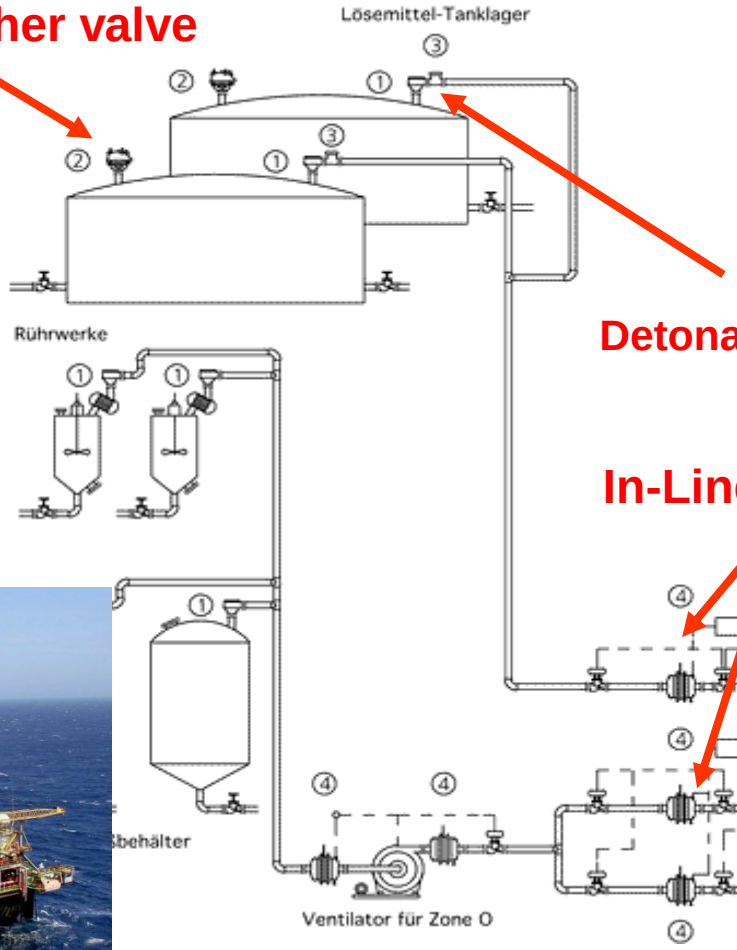
Ignition Source	Explosive Atmoshere			
	permanent	sometimes	rare	never (non-harzardous area)
permanent	3	2	1	0
sometimes	2	1	0	-
rare	1	0	-	-
never	0	-	-	-

Number of independent measures against flame transmission

Examples of applying flame arrester to the process

- Combustion of vapor from chemical process and storage

Explosion proof breather valve



Detonation Arrester with combined breather valve

In-Line Deflagration Arrester

Velocity Loop

Please keep in mind that accidents do occur!

Wrong material was used for this application.
An Aluminium housing may not be the best choice in an area of high likelihood for endurance burning

If standards are followed accidents can be prevented

Stainless steal or carbon steel are a much better choice. When ever endurance burning can occur.
Don’t forget the temperature sensor and the measures to quench the flame!

Incorrect Installations

Incorrect Installations

Maintenance of flame arrester

Maintenance shall only be done under strict observation of the relevant safety instructions. Only trained experts shall do the maintenance. Generally maintenance should only be done, if the tank or the part of plant is not under pressure and neither filled nor emptied.

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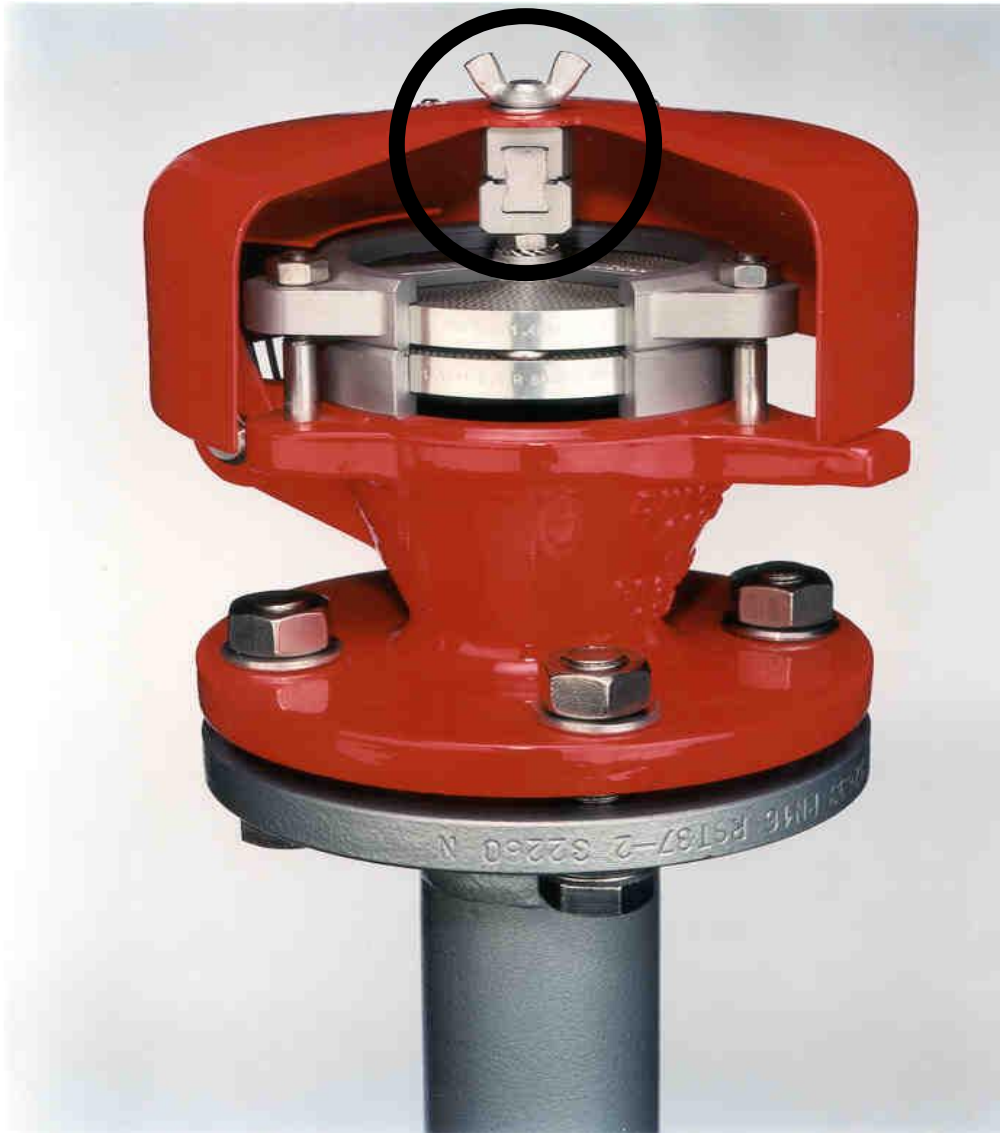
OEM Parts should be used – Welded Fusible Element



Reasons for Arrester Maintenance

- Inspection for damage or signs of flashback
- Clean arresters will allow equipment like flares/oxidizers/VRUs to function properly and prevent unit shutdown or flashback
- Preventative Maintenance and thorough cleaning will extend the lifespan of the arrester
- Clean arresters are more effective at preventing flame propagation and standing flames
- small pressure drop results in low energy consumption

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Maintenance of flame arrester

What risks your safety?

1. Corrosion of flame arrester discs

2. Mistakes/ Damages during maintenance, assembly, installations

3. Too many explosions
   (inspection intervals too long , wrong process design)

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Risk 1:
Corrosion

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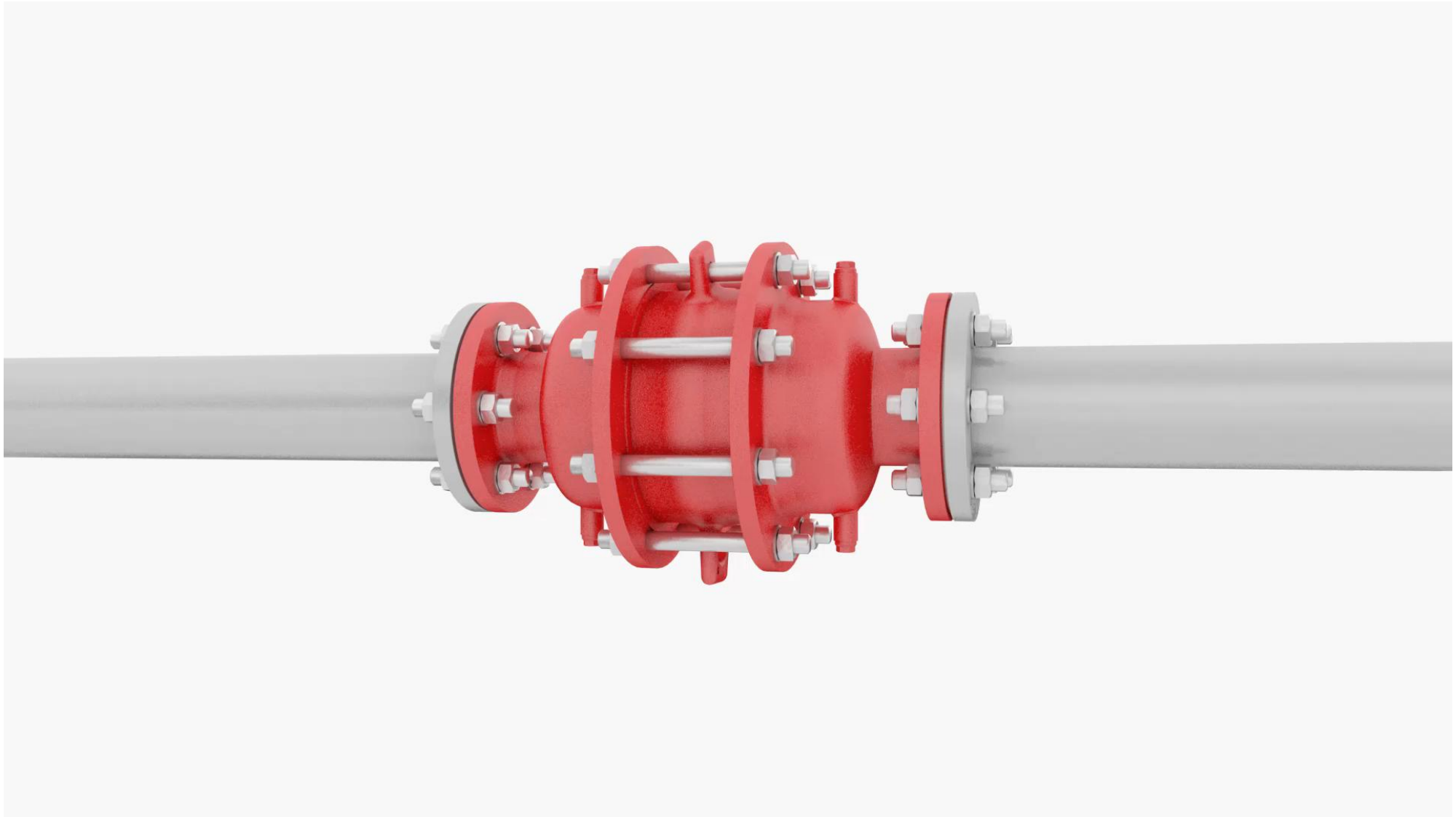
Flame Arrester Basics – How They Work



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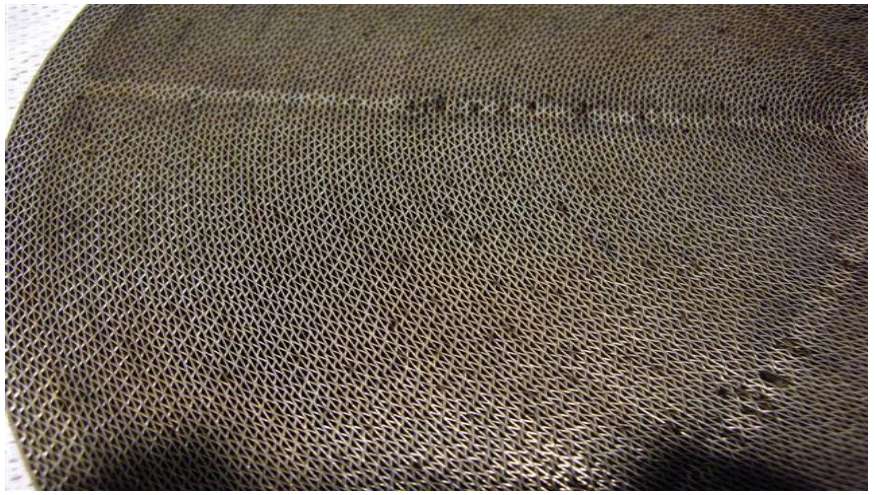
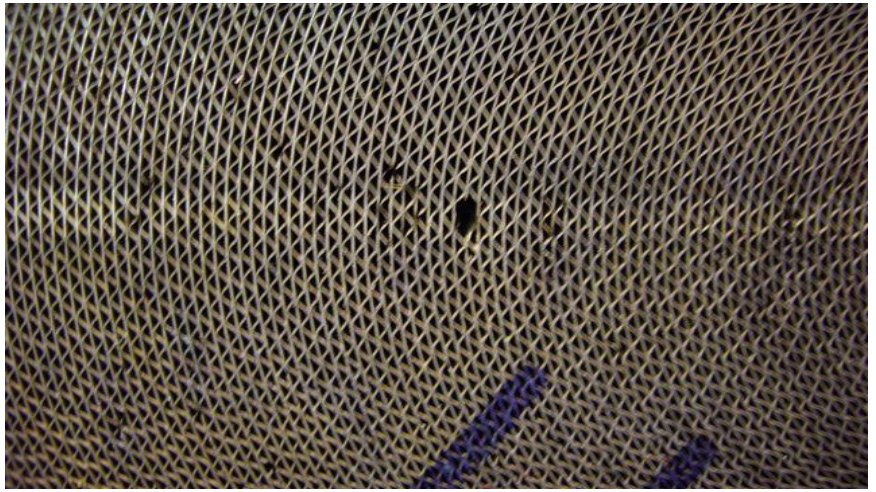
Damaged flame arresting unit (product: battery acid) regular servicing failed!

supplied 1992 – customer complaint 2010

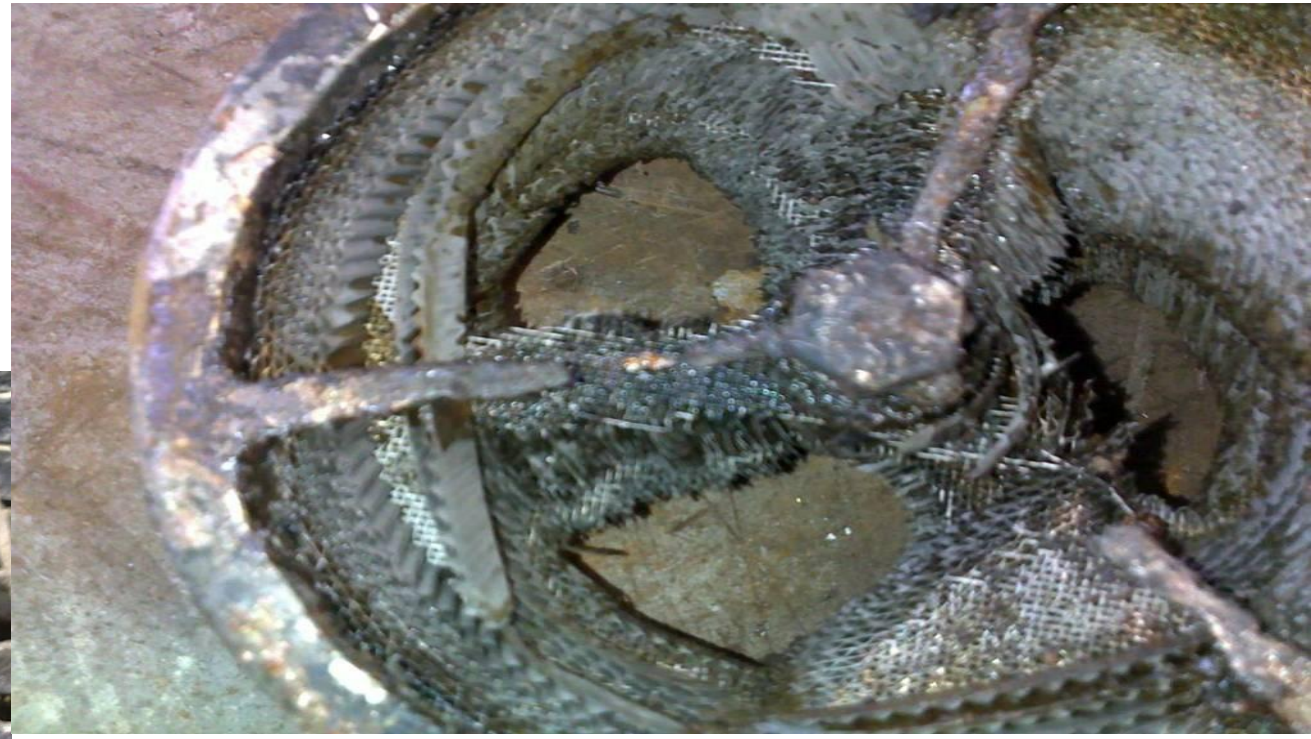
Corroded Flamefilter (pitting): Replacement!





Corrosion at a Detonation FA

DR/ES-shock absorber – 3 years operation without servicing Oil and Gas producing operation



DR/ES: Installation 2006 / first servicing 2010 – Manufacturer of cleaning agents

Risk 2:
Damages / Mistakes

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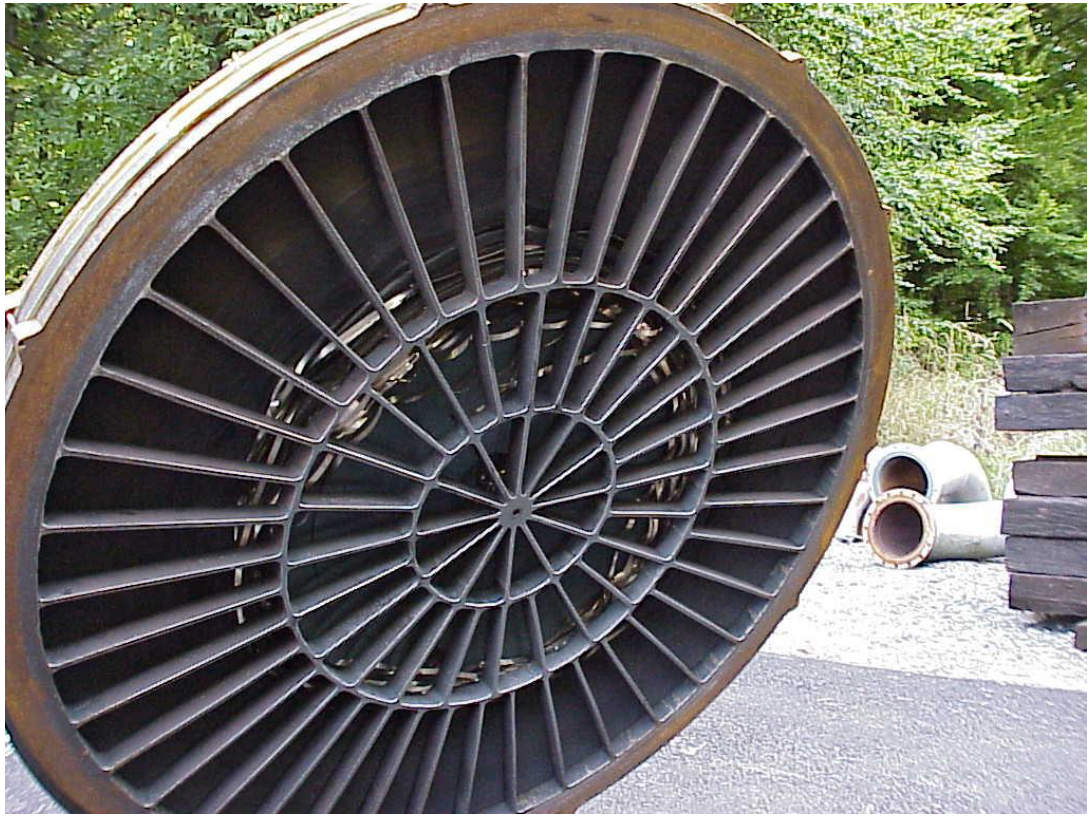
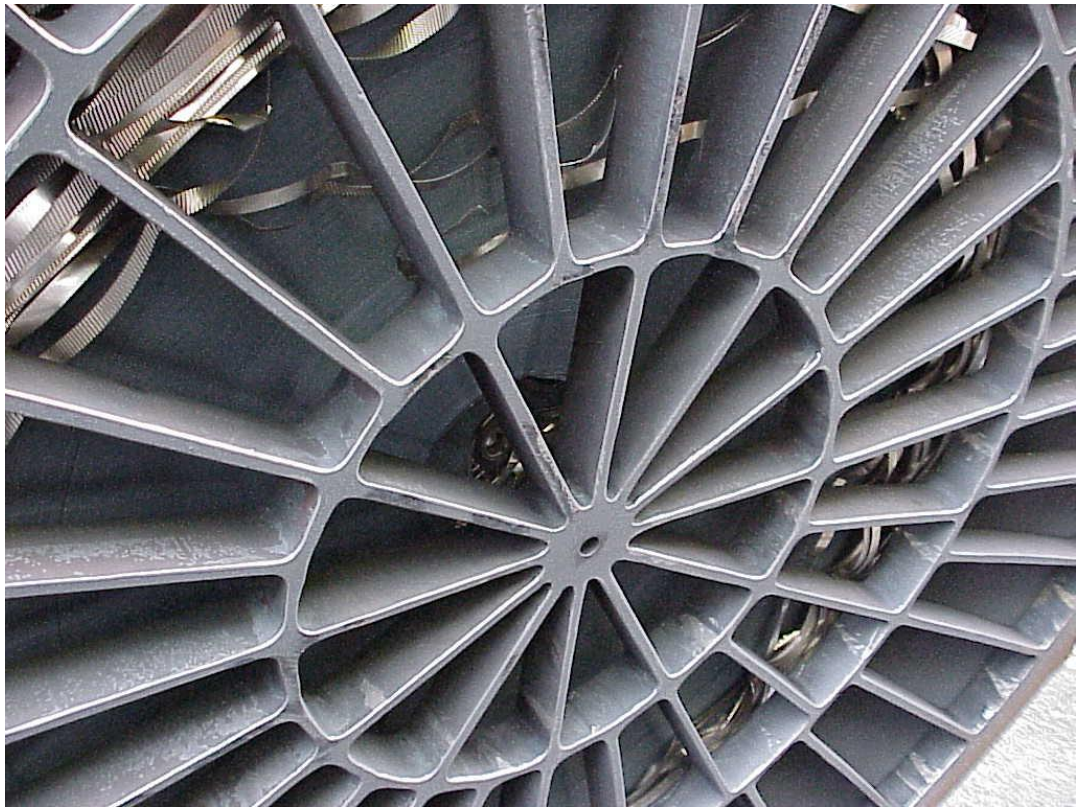
Example of Damaged Flame Arrester Unit (FAU)





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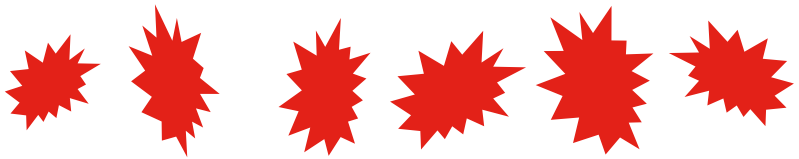
Transport damage: mechanically destroyed Flamefilter

Maintenance of flame arrester

Risk 3:

too many Explosions



<u>Risk 3 can be caused by:</u>

- Inspection intervall is too long
- Wrong process design (e.g. pressure drop issue, wrong material)

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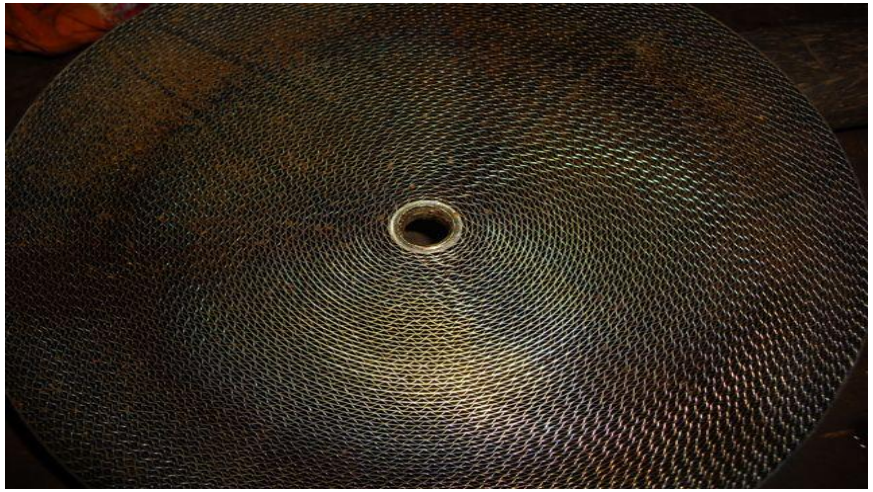
Annealing colours caused by endurance burning



Maintenance of flame arrester

Reduction of risk1 - Corrosion:

First inspection after a few weeks, in case of corrosion, change material!
Later minimum 1 inspection per year!

Reduction of risk2 - Damages / Mistakes

Read Instruction Manual carefully! Let trained technicians do the job!
Contract experienced companies e.g. PARC!
Join Maintenance Seminars at PROTEGO!

Reduction of risk3 - too many Explosions:

First inspection after a few weeks, in case of explosion signs change safety concept!
Later minimum 1 inspection per year!

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Maintenance of flame arrester in acc. to NFPA 69

***N* 15.7.2 Static Dry Flame Arrester Systems.** Arrester systems shall be designed to allow inspection for product buildup on a frequency established by facility experience.

***N* 15.7.2.1** Initially, until experience has determined otherwise, the unit shall be inspected based on manufacturer's recommendations.

***N* 15.7.2.2** Design shall allow internal inspection of flame filter elements.

***N* 15.7.2.3** If exposed to corrosive media, filter elements shall be designed so that they can be removed for inspection.

Reason for Filter Disk Design

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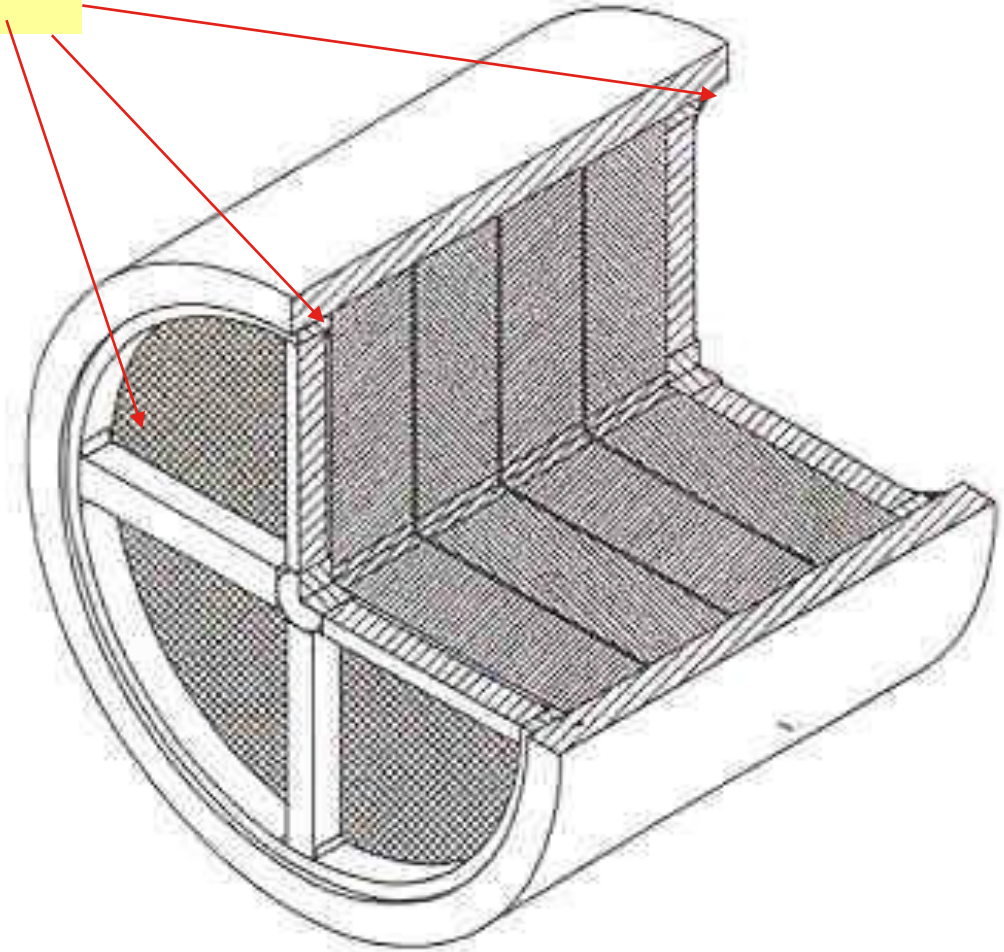
Flame arresting section common in the industry

welded



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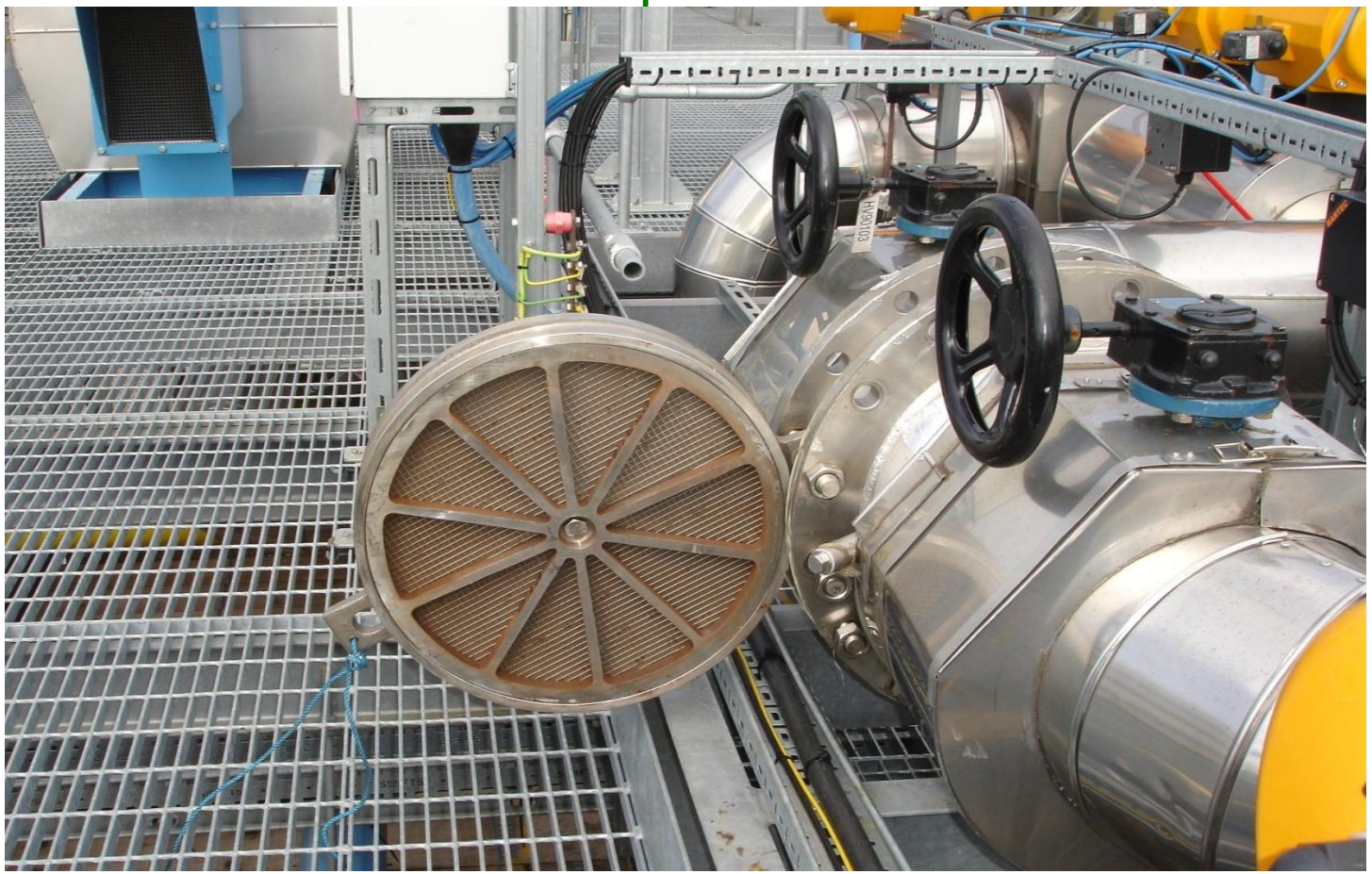
Easy inspection of the FA

Inspection of FA unit by folding out of the unit and cleaning by compressed air.
But in case of any doubts: dismantle the flame arresting unit and check the correct sequence of flamefilter



Maintenance of flame arrester

Fouling, Clogging, Condensate

In venting line: Safety topic
In process line: Efficiency topic and safety topic

Fouling, Clogging, Condensate is not problem for explosion protection but for free gas flow.

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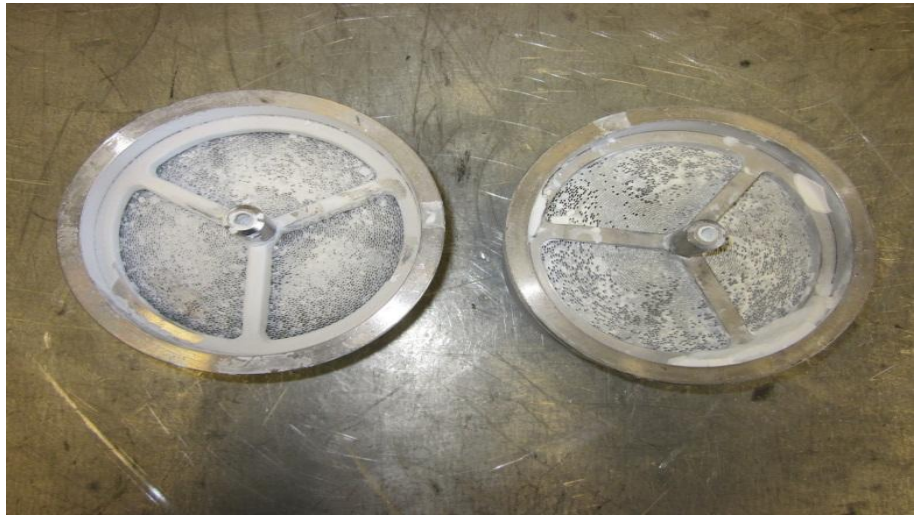
Fouling

Accumulation of condensate blocks the flow through the Detonation FA

Clogging caused by corrosion of pipeline material

Polymerization plugs the gaps of the flamefilter



Maintenance of flame arrester

In case of **Fouling, Clogging, Condensat:**

Short cleaning intervals

May be a change in process design could help:

- Insulation or heating of flame arrester (in accordance with approval temperature),
- other flame arrester design, e.g. special maintenance friendly design or different flame filter element material
- nitrogen blanketing of tank

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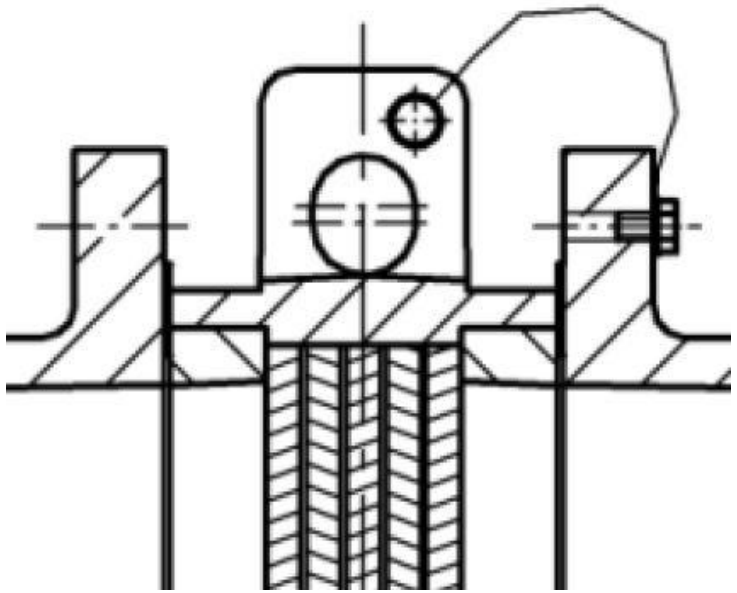
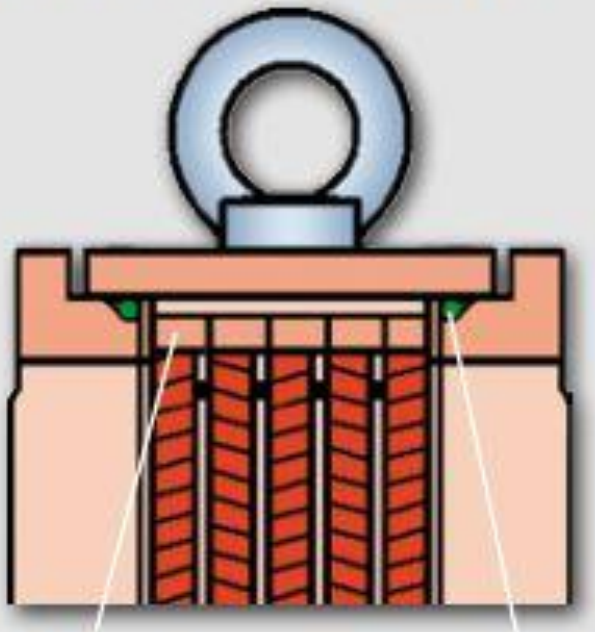
Maintenance of flame arrester

Standard design



Maintenance-friendly design



FLAMEFILTER® and O-rings prevent contamination and an explosive atmosphere.

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Maintenance of flame arrester

In case of **Fouling, Clogging, Condensat:**

How can cleaning be conducted?

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Maintenance of the Flamefilter with pressurized hot water

Maintenance of the Flamefilter

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Maintenance of flame arrester

- Cleaning of flame arrester is possible with:

  - **Compressed air**
  - **Hot water, steam**
  - **Solvents**
  - **Ultrasonic cleaning – follow PROTEGO requirements**

  - **NO metall brush!**

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Bethune Point - Methanol Tank Explosion – Hot Work Incident

The Incident

- January 11, 2006
- Methanol Tank Explosion and Fire
- Two Workers Died
- One Worker Critically Injured

Key Findings

- Severely Corroded Flame Arrester
- Improper Use of Plastic Piping
- Ineffective Safety Programs

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Bethune Point - Methanol Tank Explosion – Hot Work Incident

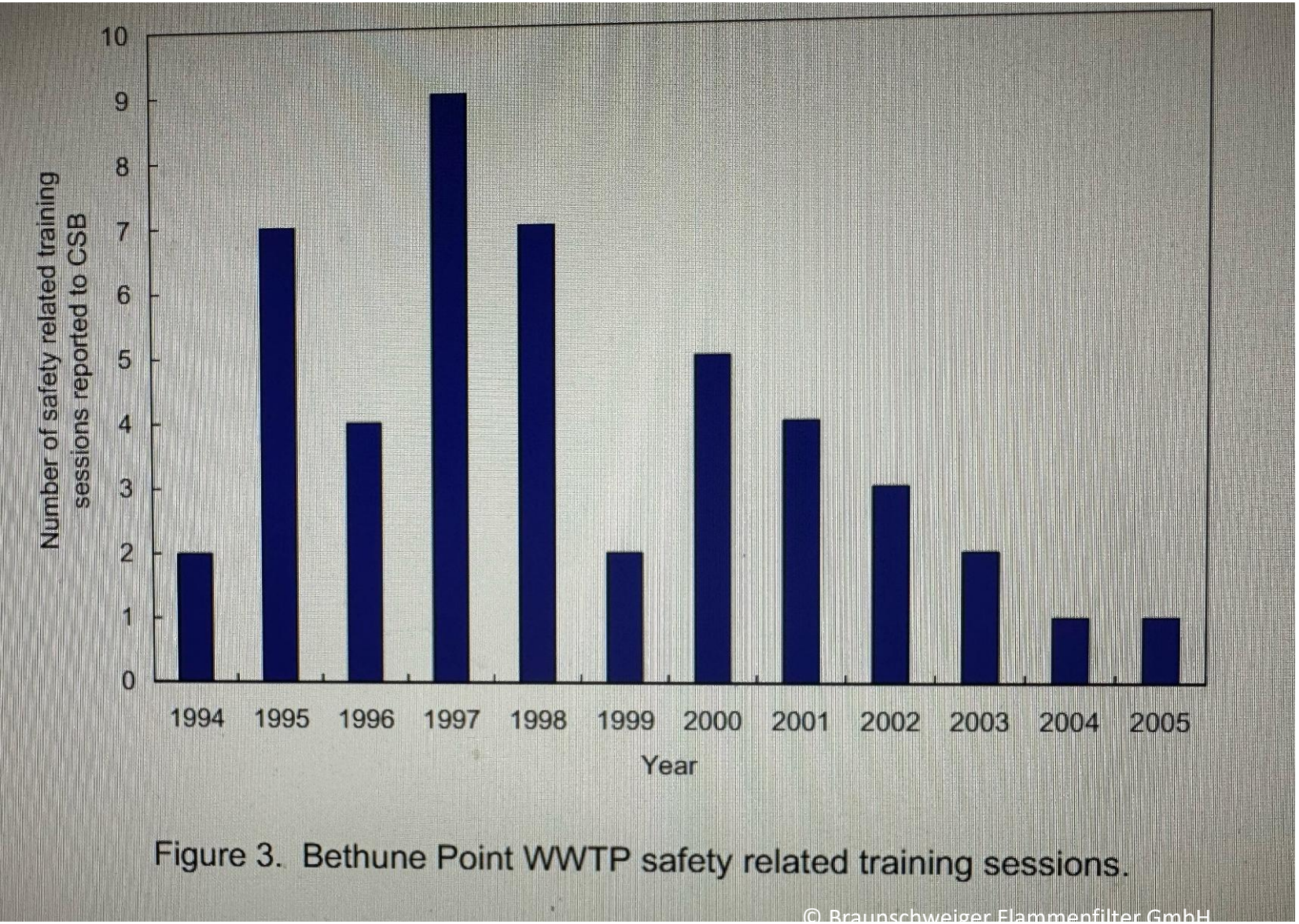

Figure 3. Bethune Point WWTP safety related training sessions.

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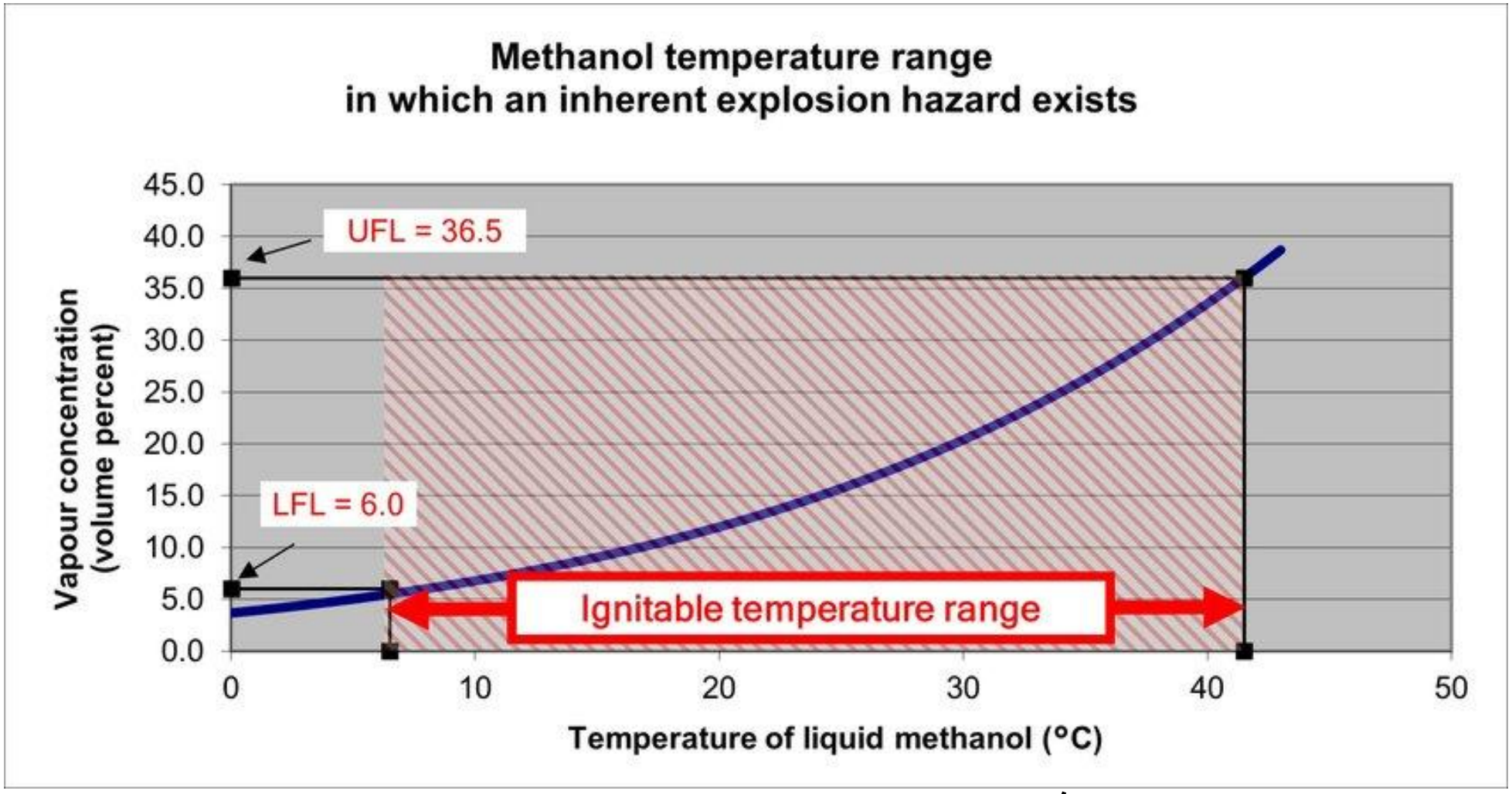
Flame Arrester

- Flame arrester was made of aluminum
- Methanol is known to corrode aluminum
- City unaware of the need to clean & inspect
- Flame arrester was not cleaned or inspected since its installation in 1993

Explosion hazard of methanol storage



Source: Conference: Society of Risk Analysis, Anual meeting 9/2006 – Hedlund/Andersen - EU`s MARS Methanol / Ethanol Research

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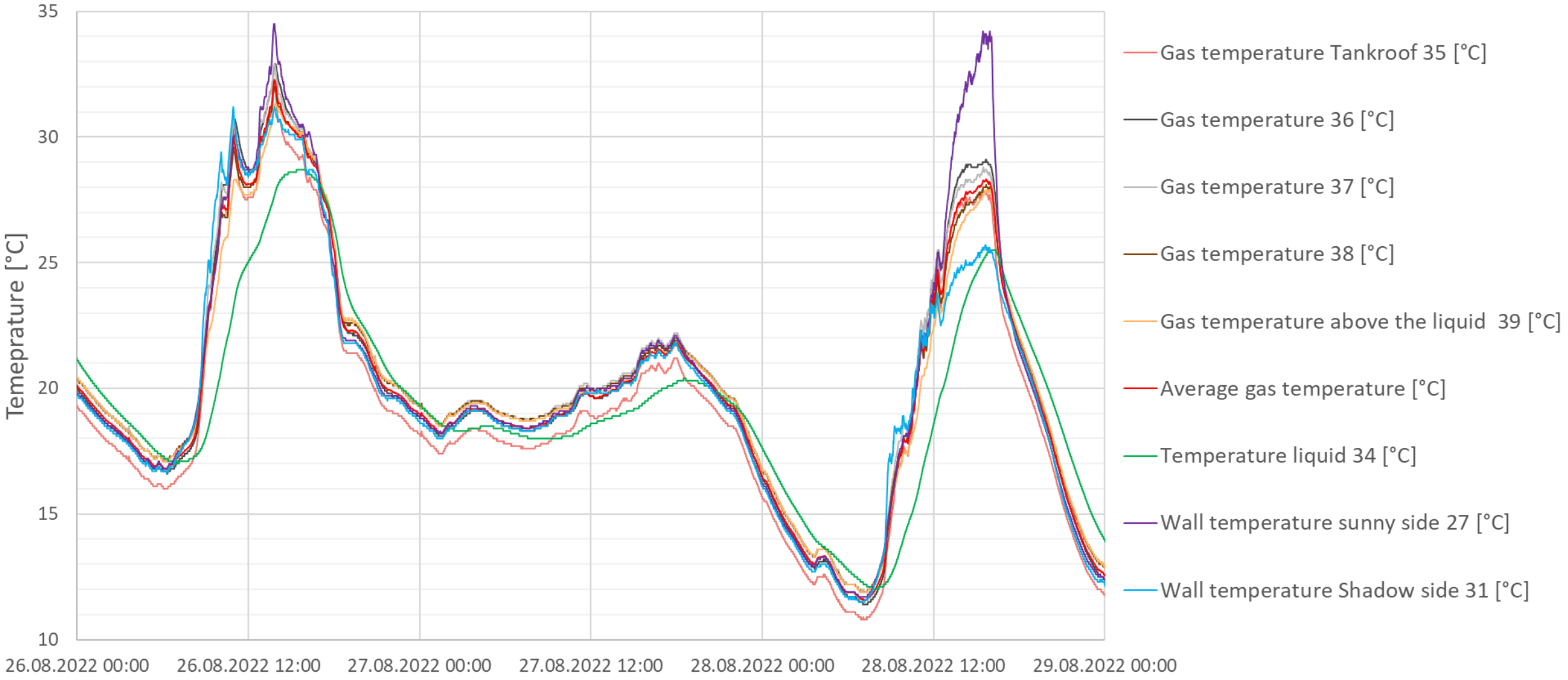
Temperature distribution - differences between gas phase, liquid and wall temperature



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PROTEGO® devices fulfill their tasks!

NEWS

Business as usual at Carbery plant after fire

SEPTEMBER 10TH, 2016 11:55 AM
BY SOUTHERN STAR TEAM

The fire on Sunday evening at the Carbery plant. (Photo: George Chambers)

Flame arrester returned to the factory after the incident!

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End-of-line flame arrester during endurance burning test

- MESG Value of Methanol is 0.92 mm
- hexane vapor test as per ISO 16852/IEC 80079-49 is not sufficient
- read the test standard carefully
- special testing with alcohol vapor is required for endurance burning

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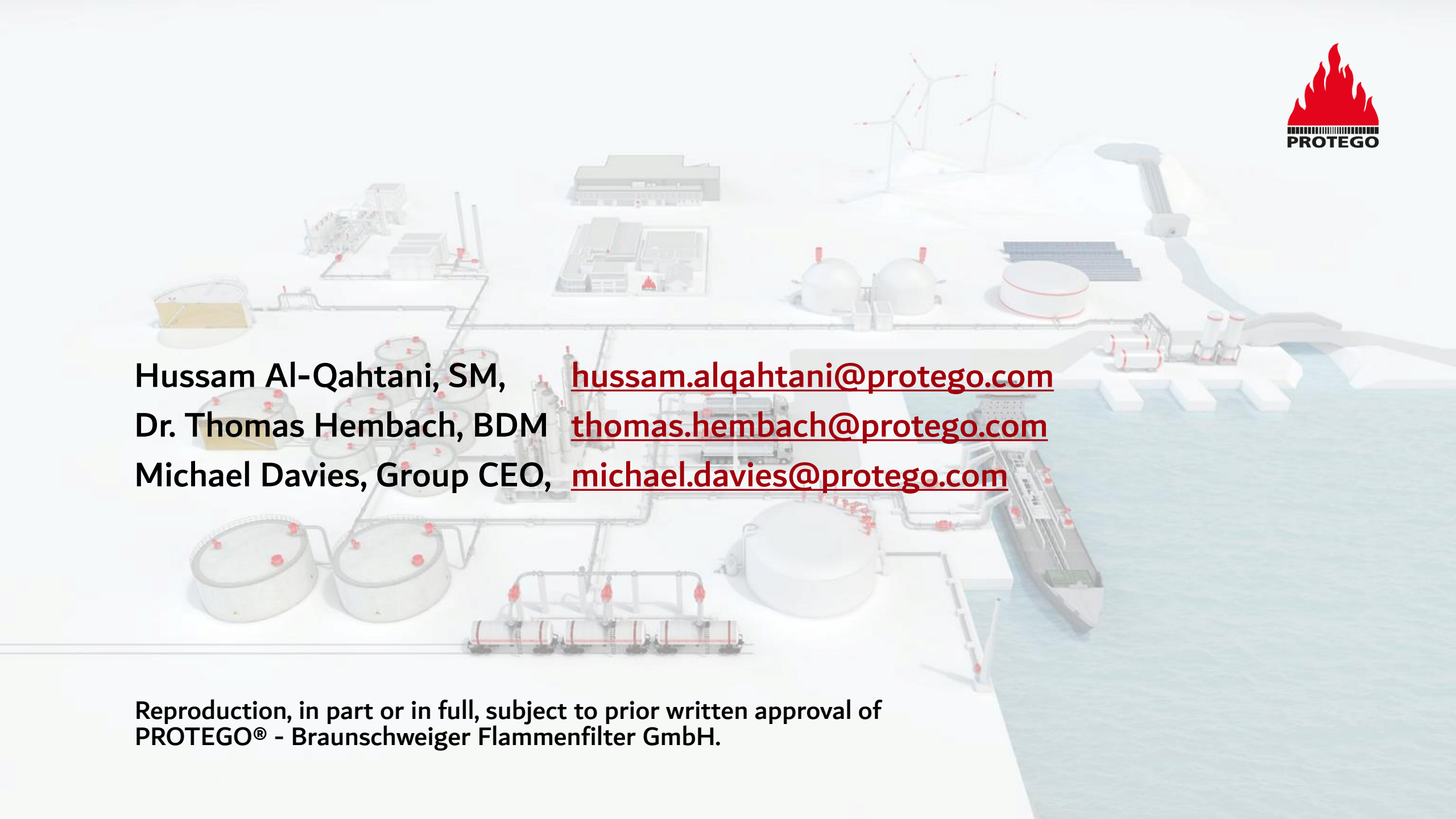

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