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Independent guidance
on fluorine-free foam
and AFFF

AFFF and fluorinated foam concentrates – The final chapter

Regulatory restrictions on foam concentrates and lessons from the research on alternatives

Eike Peltzer, E.P.FIRE

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- 2008 – 2021: Manager Fire & Rescue Service at LyondellBasell, Germany
- B.Eng. in Rescue Engineering (TH Cologne, Germany),
- M.Sc. in Disaster Management (Coventry University, UK)
- Chair of the working group on firefighting foam of the WFVD (German Industrial Firefighters Association)
- 2-year German national training program for senior fire officers

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International regulation of PFAS

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It‘s a bit complicated …

Perfluorinated Compounds		"C8 foam"	"C6 foam"	"pure C6 foam"	"fluorine free"
Perfluorooctanesulfonic acid (PFOS)	ug/L	280000	<140	<140	<25
Perfluorooctanoic acid (PFOA)	ug/L	7200	6400	<190	<25
Perfluorohexanesulfonic acid(PFHxS)	ug/L	33000	<300	<300	<25
Perfluorohexanoic acid (PFHxA)	ug/L	11000	20000	320	<25
6:2 Fluorotelomer sulfonic acid	ug/L	<280	41000	49000	<25
8:2 Fluorotelomer sulfonic acid	ug/L	<250	11000	<250	<25
Perfluorobutanoic acid (PFBA)	ug/L	1900	1500	<210	<25
Perfluorobutanesulfonic acid (PFBS)	ug/L	8000	<210	<210	<25
Perfluoropentanesulfonic acid PFPes	ug/L	7400	<190	<190	<25
Perfluoropentanoic acid (PFPeA)	ug/L	2100	2300	<230	<25
Perfluoroheptanoic acid (PFHpA)	ug/L	2600	830	<250	<25

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International regulation of PFAS

Regulation (EU) 2019/1021 („EU-POP-Regulation“) (1)

185 parties
(Notable non-ratifying states: United States, Israel, Malaysia)

REACH

Regulation (EC) 1907/2006 („REACH-Regulation“) (2)

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UK regulation of PFAS

Stockholm Convention on persistent organic pollutants (POPs)

The Persistent Organic Pollutants Regulations 2007 (3)

UK REACH

European Union (Withdrawal) Act 2018 (4)

- The key principles of the EU REACH Regulation were retained in UK REACH
- EU REACH continues to apply in Northern Ireland

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Current restrictions:
Timeline for PFOS, PFOA and C9–C14 PFCAs [5][6][7]

27/06/2011
PFOS

- Use of PFOS based foams prohibited

04/07/2020
PFOA

- Manufacturing and sales prohibited
- Training prohibited

01/01/2023
PFOA and C9-C14 PFCAs

- Using and testing of foam only if all releases are contained

25/02/2023
C9-C14 PFCAs

- Manufacturing and sales prohibited

04/07/2025
PFOA and C9-C14 PFCAs

- All uses prohibited

Limit values:
25 ppb for PFOA and its salts
1000 ppb for the sum of PFOA-related substances
25 ppb for the sum of C9–C14 PFCAs and their salts
260 ppb for the sum of C9–C14 PFCA-related substances

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You can still use AFFF if …

… you have pure C6 foam with PFOS, PFOA and C9–14 PFCAs below the limit values.

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But not for long …

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Proposal to restrict PFAS in firefighting foam in the EU [8]

- Expected for 2023
- Proposed limit value: 1000ppb (sum of PFAS)
- Transitional periods per sector

Sector/type of use or placing on the market	Transitional period from entry into force
Seveso establishments	10 years
Other industries	5 years
Civilian aviation	5 years
Defence	5 years
Municipal fire services	1.5 years
Ready-to-use applications (fire extinguishers)	5 years
Marine applications	3 years
Training and testing	1.5 years
Export	10 years

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Summary on restrictions

Current restrictions

- PFOS and precursors
  Active ingredient in (very) old AFFFs
- PFOA and precursors
  Can be present as impurities in older AFFFs
- C9-C14 PFCAs
  Can be present as impurities in older AFFFs

Upcoming restrictions

- EU: PFHxA and precursors
  Will likely affect all AFFFs
- EU: PFAS in firefighting foam
  Will affect all AFFFs
- Stockholm Convention: PFHxS and precursors
  Can be present as impurities in AFFFs

Pure C6 foams based on PFHxA precursors can still be used. But further restrictions are coming.

AFFF is used here to describe all PFAS-based foams

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What properties matter in firefighting foam?

Now that we won‘t have aqueous film forming foams anymore

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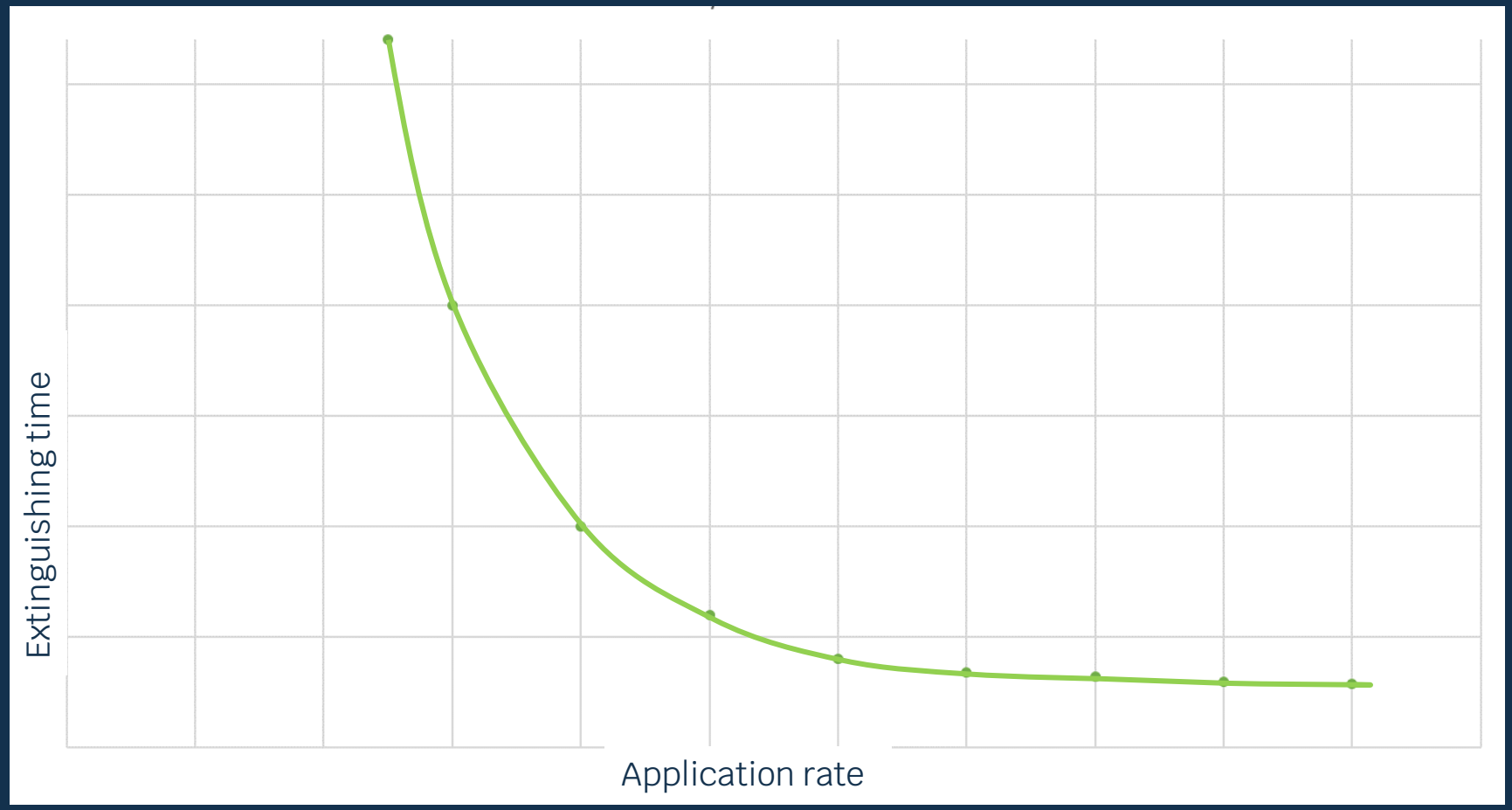
Application rate (density)
The “L-Curve”



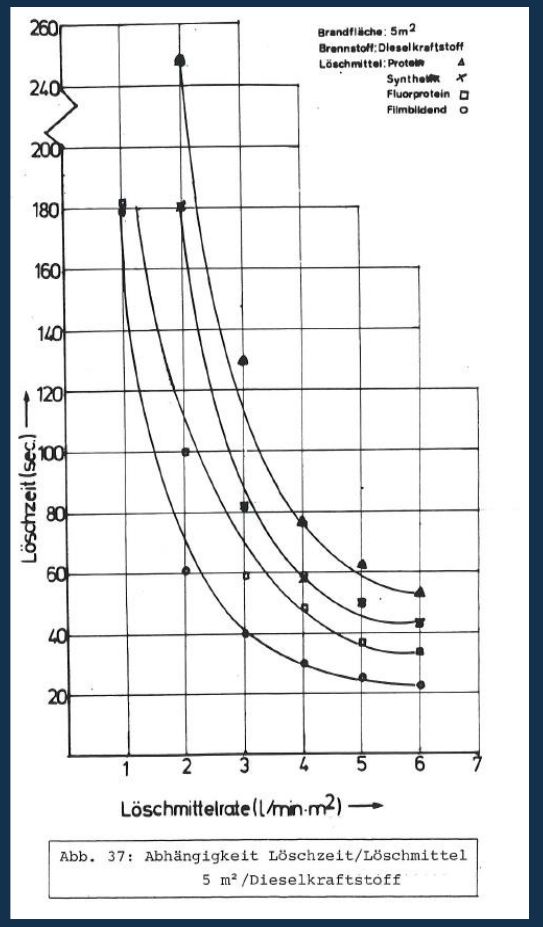


Abb. 37: Abhängigkeit Löschzeit/Löschmittel
5 m²/Dieselkraftstoff

(9)

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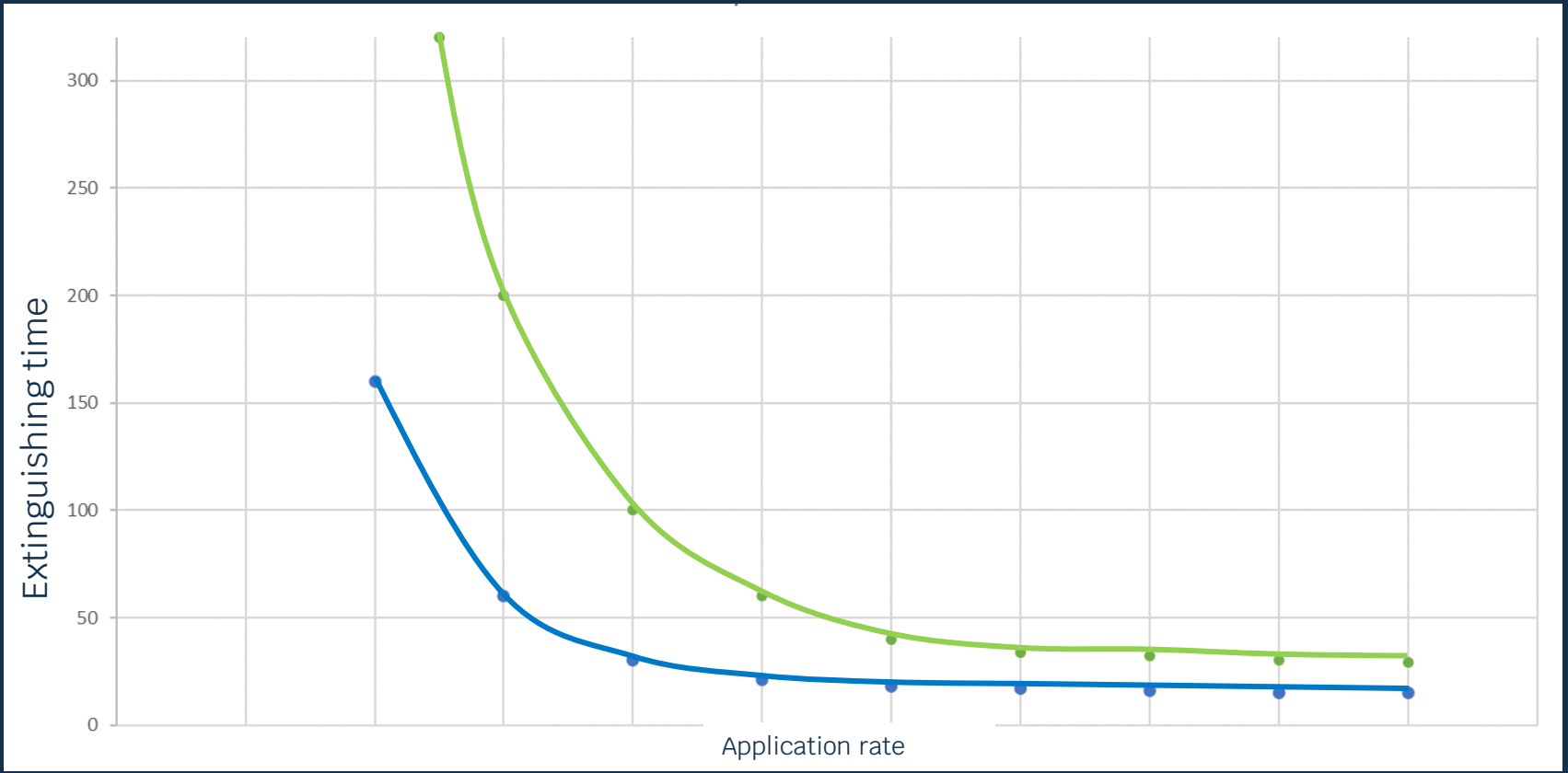
Application rate (density) The “L-Curve”



Observations

- There is a critical application rate. Below this rate, foam does not extinguish
- At a low application rate, increasing the rate results in a significantly faster extinguishing time
- This effect is smaller with higher (more realistic) application rates
- A further increase in the application rate hardly has any effect (unless you want to compensate for losses and add a safety factor)
- With a higher application rate of a poor foam concentrate, you can achieve the same extinguishing time as that of a better one

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Expansion ratio

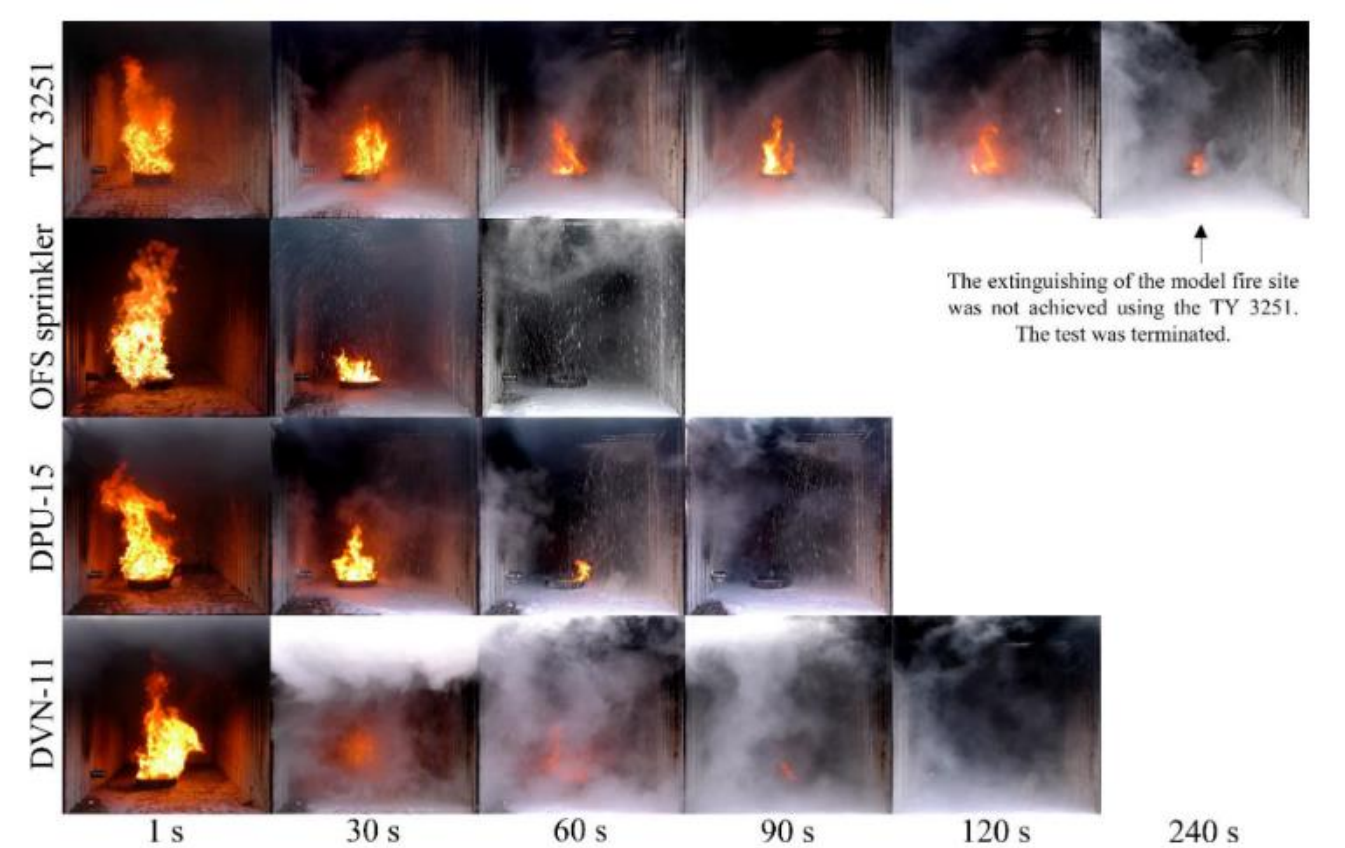
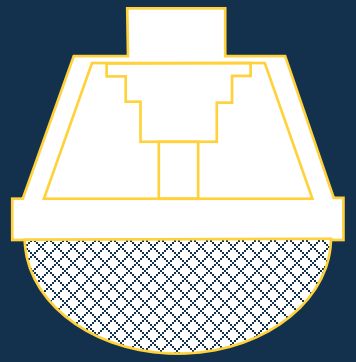


Fig. 9. The process of the model fire site extinguishing by the sprinklers.

(10)

- Sprinkler design influences expansion ratio
- Expansion ratio influences extinguishing performance
- Conventional sprinklers might no create sufficient expansion



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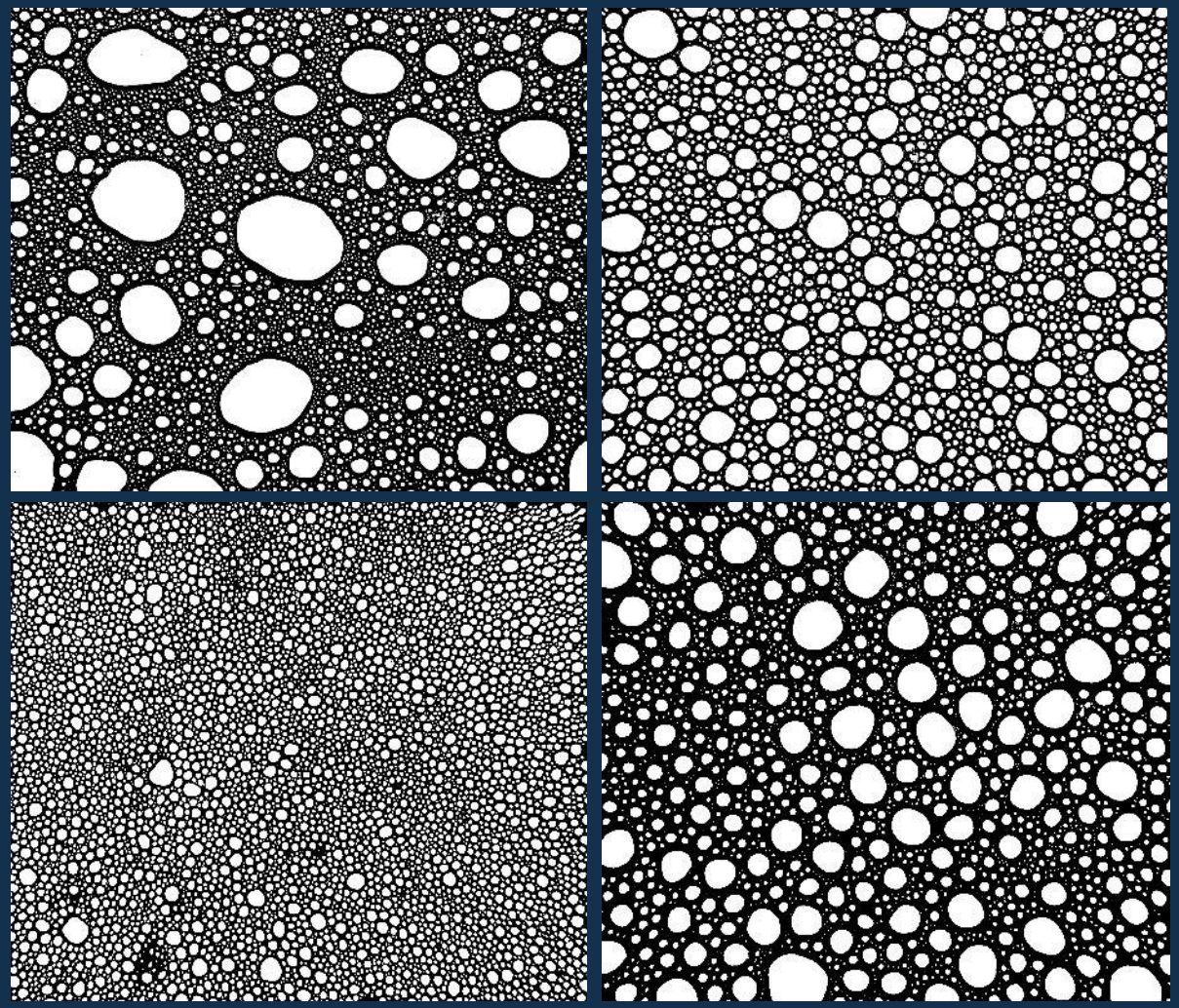
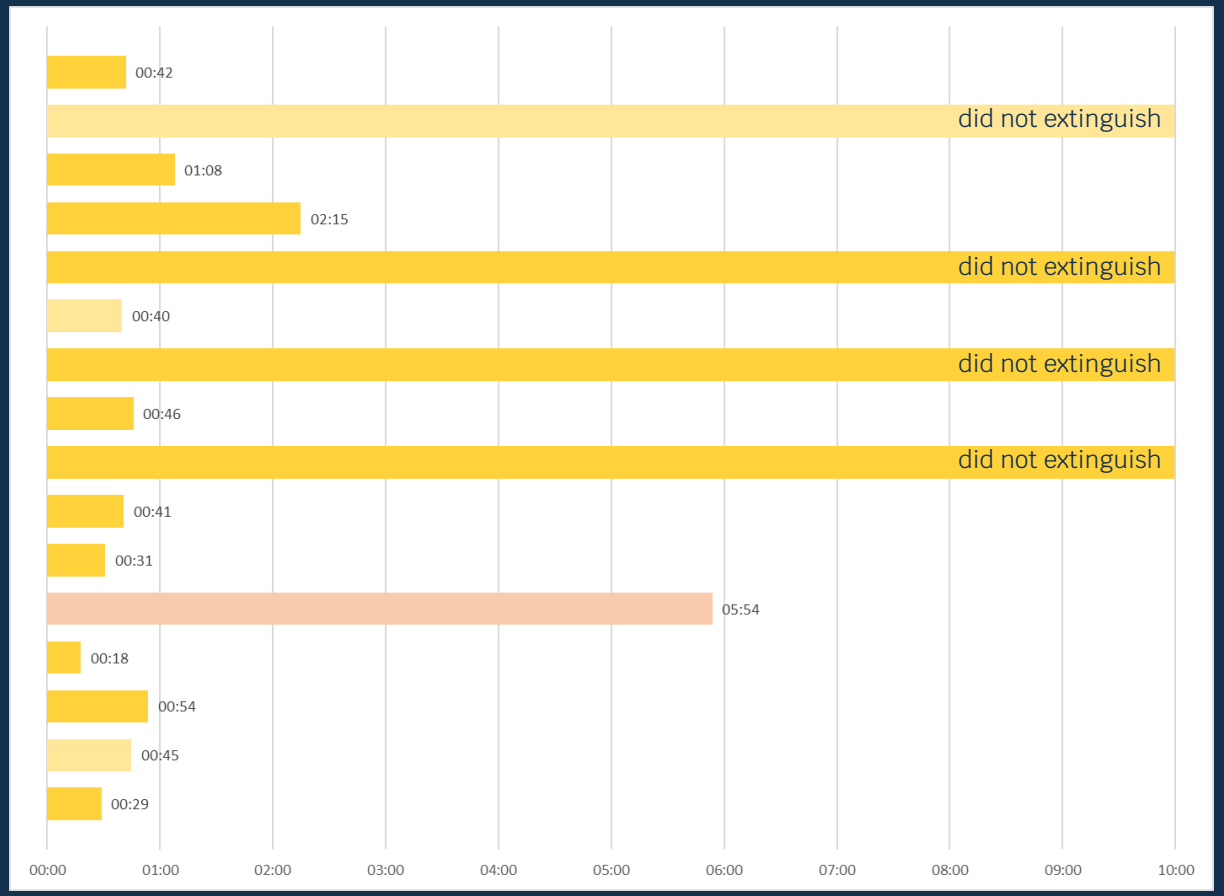
Bubble Size Distribution



- Varying the application device influences bubble sizes and their distribution (same foam concentrate used)
- Bubble size (distribution) influences extinguishing performance [11]

All pictures: Eike Peltzer, E.P.FIRE

(Polar) Fuels



Tests of 3 different fluorine-free foams on 16 different polar fuels according to EN1568-4 Annex I

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All pictures: Eike Peltzer, E.P.FIRE

Viscosity

- Many fluorine-free foam concentrates are pseudoplastic
- Viscosity decreases as the foam concentrate flows
- Viscosity increases with lower temperatures
- Proportioning system need to be able to cope with these characteristics

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All pictures: Eike Peltzer, E.P.FIRE

What matters during a transition to fluorine free foam?

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5 big issues

1. Time
2. Risks
3. Foam concentrate
4. Changes to your system
5. Cleaning the system

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Time

- By when do you have to transition to fluorine-free foam?
- This depends to a great extent on
  - the PFAS values in your firefighting foam concentrate and
  - on transition periods in upcoming restrictions
- Only a PFAS analysis of the foam concentrate will give you accurate information.
- Manufacturers won’t know the PFAS levels of batches from old foam concentrate
- Cross contamination can influence PFAS values

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Risks

- The performance of firefighting foam is fuel depended
- Current standards might no reflect this aspect sufficiently, especially for polar fuels

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Foam concentrate

- Development of fluorine-free foam concentrates is still ongoing
- Manufacturers introduce improved versions regularly
- Listing and approvals might not be able to catch up so quickly
- Some foams are specifically designed for sprinkler systems

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Changes to your system

- Changes to your fire protection system might be necessary to ensure sufficient performance with fluorine-free foam
- Sprinklers might need to be changed
- Foam proportioners need to be adjusted or changed
- In some cases densities or application time might need to be adjusted

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Cleaning systems

- Limit values are so low that small residues of AFFF can contaminate fluorine-free foam concentrate
- Systems need cleaning in order to prevent cross contamination from PFAS in old foam concentrate
- Debate on the right approach: Is “triple rinsing” enough?
- Specialised chemical cleaning companies promote different approaches

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Sources

(1) Regulation (EU) 2019/1021

(2) Regulation (EC) 1907/2006

(3) The Persistent Organic Pollutants Regulations 2007

(4) European Union (Withdrawal) Act 2018

(5) Commission Delegated Regulation (EU) 2020/784

(6) Commission Regulation (EU) 2021/1297

(7) Commission Regulation (EU) No 757/2010

(8) ECHA (2022): Restriction of per- and polyfluoroalkyl substances (PFASs) in firefighting foams (https://echa.europa.eu/de/-/eu-restriction-of-per-and-polyfluoroalkyl-substances-pfas-in-firefighting-foams)

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(10) Kamluk, Likhamonov, Grachulin (2020): Field testing and extinguishing comparison of the optimized for higher expansion rates deflector type sprinkler with other foam and foam-water sprinklers

(11) Laundess et al. (2011) Small-Scale Test Protocol for Firefighting Foams DEF(AUST)5706 - Effect of Bubble Size Distribution and Expansion Ratio

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