



Impulse Storm Ltd.

RadEX

Testing of aerosol fire extinguishers

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1 Basic information

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Time of the test: 26.3.2025

Implementation place: Pelastusopisto's training area, Korvaharju Kuopio.

Test: RadEX gas analysis of aerosol extinguisher

2 Introduction

Impulse Storm Ltd. tested the safety of two laboratory prototypes of aerosol extinguishers. These have reported to perform in 2 m³ space by an active compound weight of 15 and 20 grams, without safety systems such as filters, built-in ignition mechanisms, oxidizers, or artificial cooling. The testing was carried out by the Pelastusopisto's (Emergency Services Academy Finland) R&D services. The test examined the concentrations of gases following the product's discharge. Measured substances included carbon monoxide, oxygen, nitric oxide, and aerosols. A commercially available product from the world's leading extinguisher manufacturer was used as a comparative extinguisher, which has reported to perform in 1 m³ space by an active compound weight of 100 grams. The product is certified according to the standards UL, EPA SNAP and EN 15276-1. From here on, commercial extinguisher has referred as Product X.

3 Materials and methods

The test was conducted in the fire theatre of the Pelastusopisto's training area. The conditions in the burning chamber correspond to the normal room temperature. The actual test chamber was a 2 m³ and made by the customer (see figure 1), in which an aerosol extinguishing cartridge mounted on the ceiling was triggered by an electric detonator. The prototype did not have its own ignition system. The comparison extinguisher was triggered in a 1 m³ chamber.

Dust samples were collected on a 37 mm membrane filter made of cellulose acetate with a pore size of 0.8 µm. The filter was packed in a Millipore filter housing (MHWP037A0) (figure 3) and was analysed gravimetrically at the Finnish Institute of Occupational Health in Helsinki. The sample was collected using a pump (from Gilian) at a flow rate of 1000 ml/min (figure 3). Three samples were taken from



each discharge (discharges without fire). Gas measurements were performed with a multi-gas meter (figure 5) and a flue gas analyser (figure 4) (table 1). Temperatures were also measured in the chamber using a data logger (figure 6) from the cartridge discharge area and the back wall of the chamber (table 2). This laboratory prototype uses an atypical ignition method, so the temperature measurement should not be considered representative of the RadEX product.

3.1 Test setup

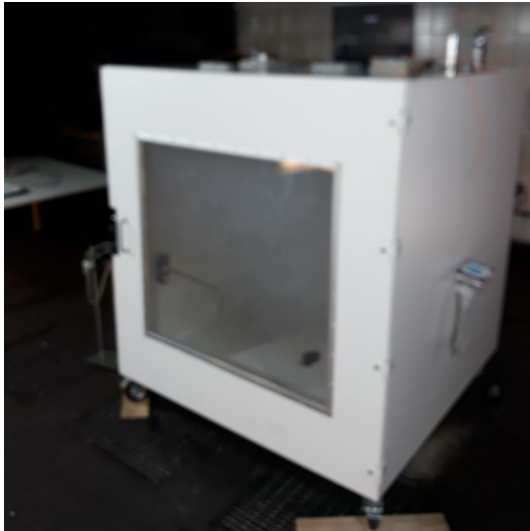


Figure 1. Test chamber.



Figure 2. Test equipment, flue gas analysers 1 and 2, and aerosol and multi-gas meter (from left to right).



Figure 3. Aerosol measurement equipment.



Image 4. Testo 340 flue gas analyser.



Figure 5. Multi-gas meter X-am 5000.



Figure 6. Graphtec G L840 data logger and K-type thermocouple wire.

3.2 Locations of gas detector

Table 1. Locations of the multi-gas meter and flue gas analysers.

Laite	Sijainti
Multi-gas meter	300 mm from the door, 900 mm from the roof
Flue Gas Analyser 1	approx. 600 mm from the door, approx. 700 mm from the roof
Flue Gas Analyser 2	approx. 900 mm from the door, approx. 700 mm from the roof

3.3 Locations of temperature sensors

Table 2. Locations of temperature measurement sensors.

Channel	Location
Ch 1	Next to the nozzle discharge port
Ch 2	200 mm from the nozzle downwards
Ch 3	400 mm from the nozzle downwards
Ch 4	On the back wall of the chamber, 900 from the roof down
Ch 5	On the back wall of the chamber, on the surface of the base

4 Reference values for the gas and aerosol measurements

The guidelines for chemically hazardous substances define an immediately hazardous area from which people must be rescued. Staying in an area for 30 minutes without a respirator can cause permanent health hazards and make it difficult to leave the area. AEGL₃-value for 30 minutes are applied to these purposes. The AEGL₃-value established for carbon monoxide is 600 ppm (EPA, 2024). Correspondingly, the immediately hazardous to health value (IDHL) established by NIOSH is 1200 ppm (NIOSH, 2021).

Nitric oxide has been established an IDHL limit value of 100 ppm (NIOSH, 2021), but there are no AEGL₃-values for it.

In Finland, the occupational exposure limit value for oxygen concentrations is 18% (Ministry of Social Affairs and Health 2025). Lowering concentration below occupational exposure limit value can cause oxygen deficiency.

In Finland, an eight hours occupational exposure limit value for inorganic dust is 10 mg/m³ (Ministry of Social Affairs and Health 2025).

5 Results: Temperature measurements

5.1 Test 1, RadEX 15, without fire

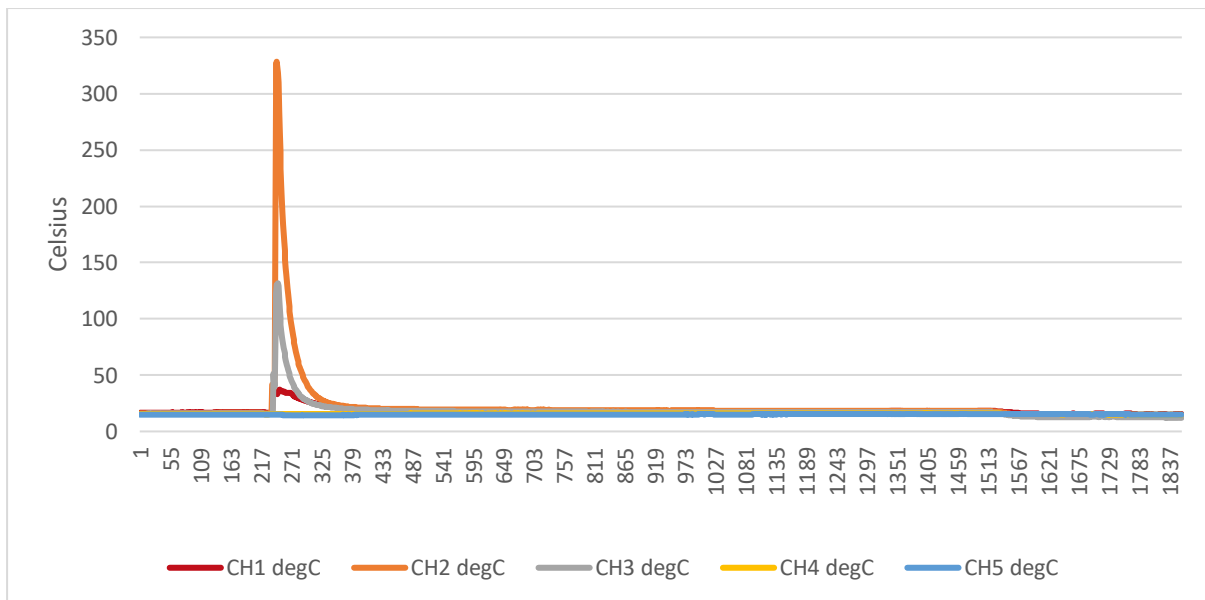


Figure 7. Channel temperatures °C.

During the test, the highest temperatures were measured in channels 2 (330°C) and 3 (132°C). At other measurement points, temperatures did not rise significantly.



5.2 Test 2, RadEX 20, without fire

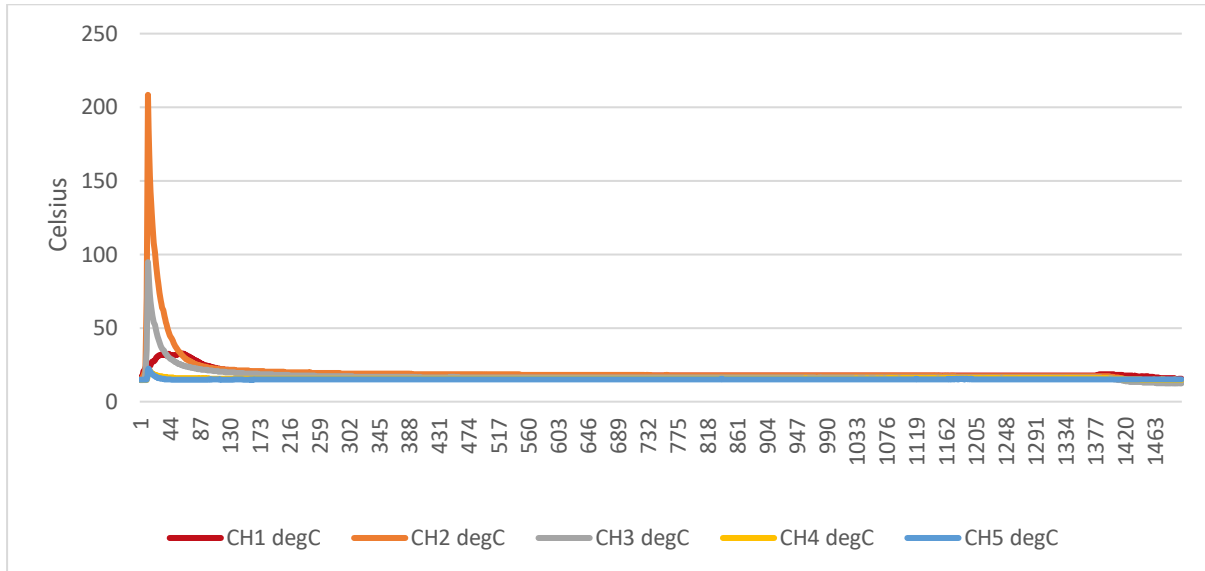


Figure 8. Channel temperatures °C.

During the test, the highest temperatures were measured in channels 1 (210°C) and 3 (95°C). At other measurement points, temperatures did not rise significantly.

5.3 Test 3, Product X without fire

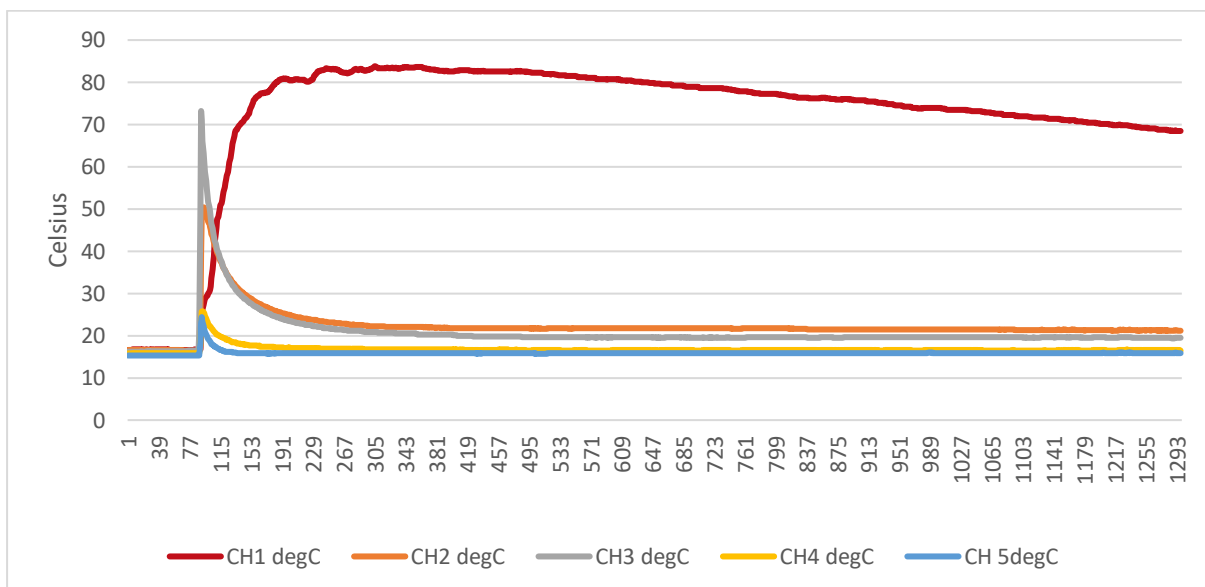




Figure 9. Channel temperatures °C.

During the test, the highest temperatures were measured in channels 1 (84°C) and 3 (73°C). At other measurement points, temperatures did not rise significantly.

5.4 Test 4, Product X with fire

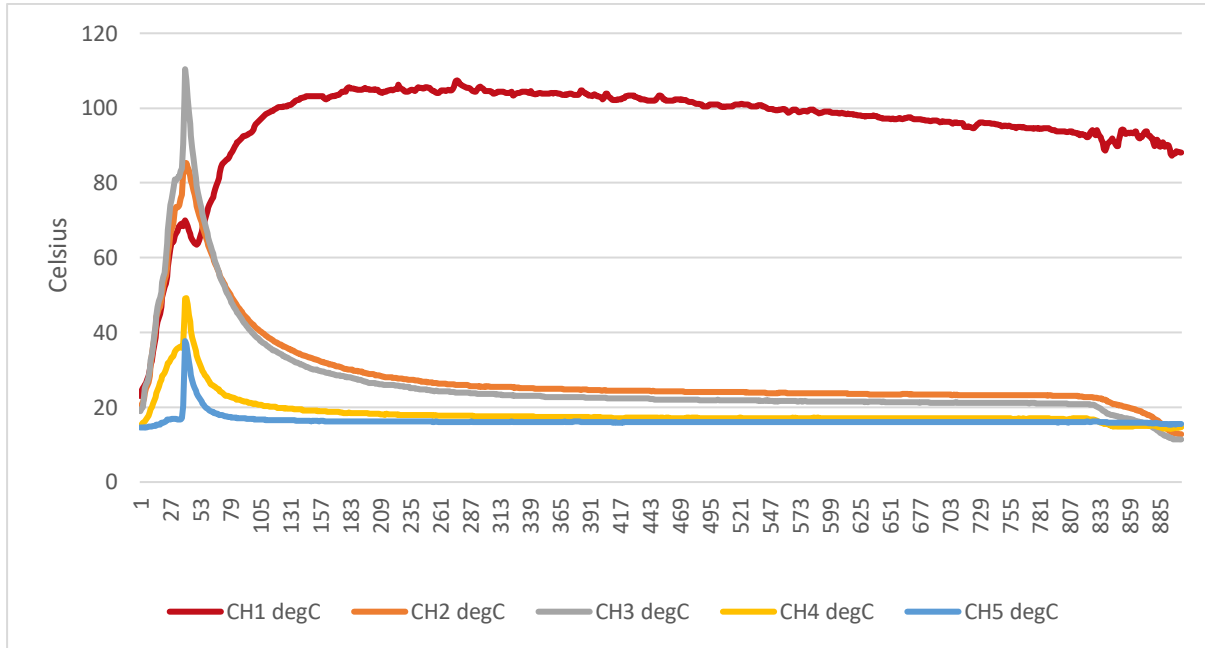


Figure 10. Channel temperatures °C.

During the test, the highest temperatures were measured in channels 1 (110°C), 2 (85°C) and 3 (110°C). At other measurement points, temperatures did not rise significantly.



5.5 Test 5, RadEX 20, with fire

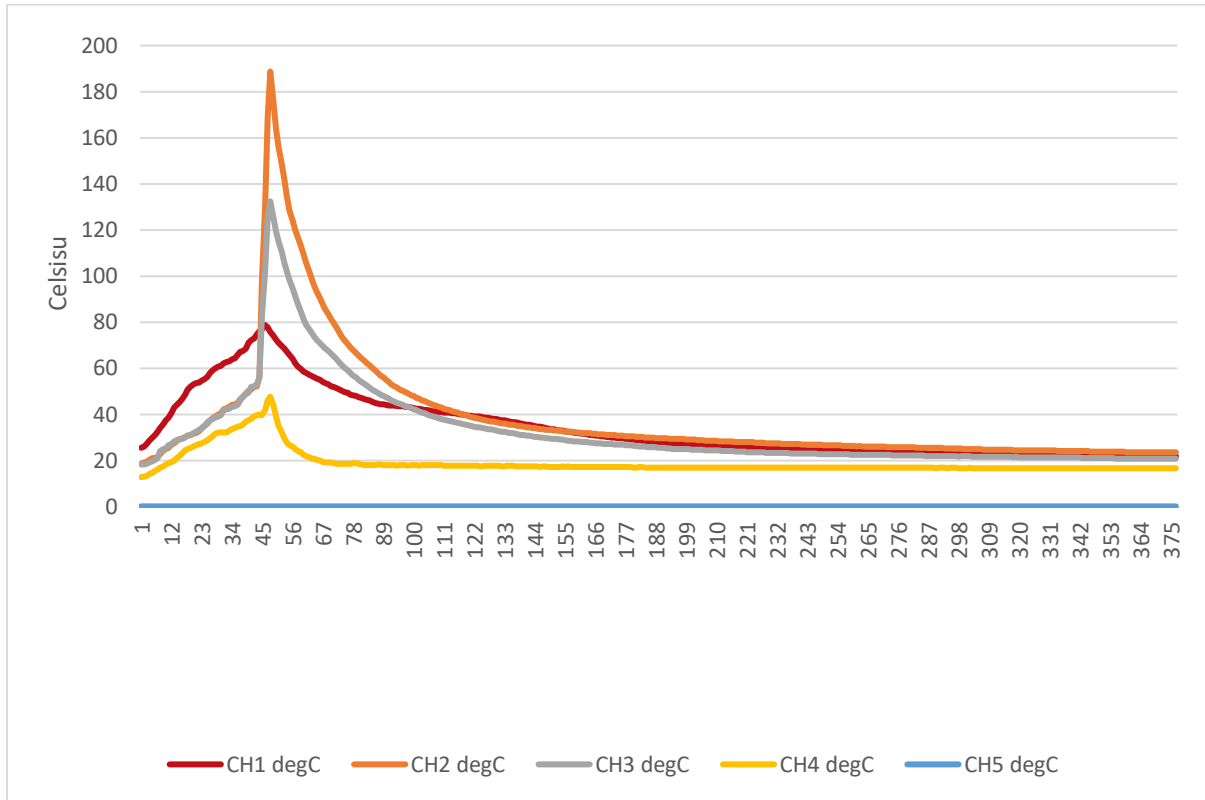


Figure 11. Channel temperatures °C.

During the test, the highest temperatures were measured in channels 2 (190°C) and 3 (130°C). At other measurement points, temperatures did not rise significantly.



5.6 Test 6, RadEX 15, with fire

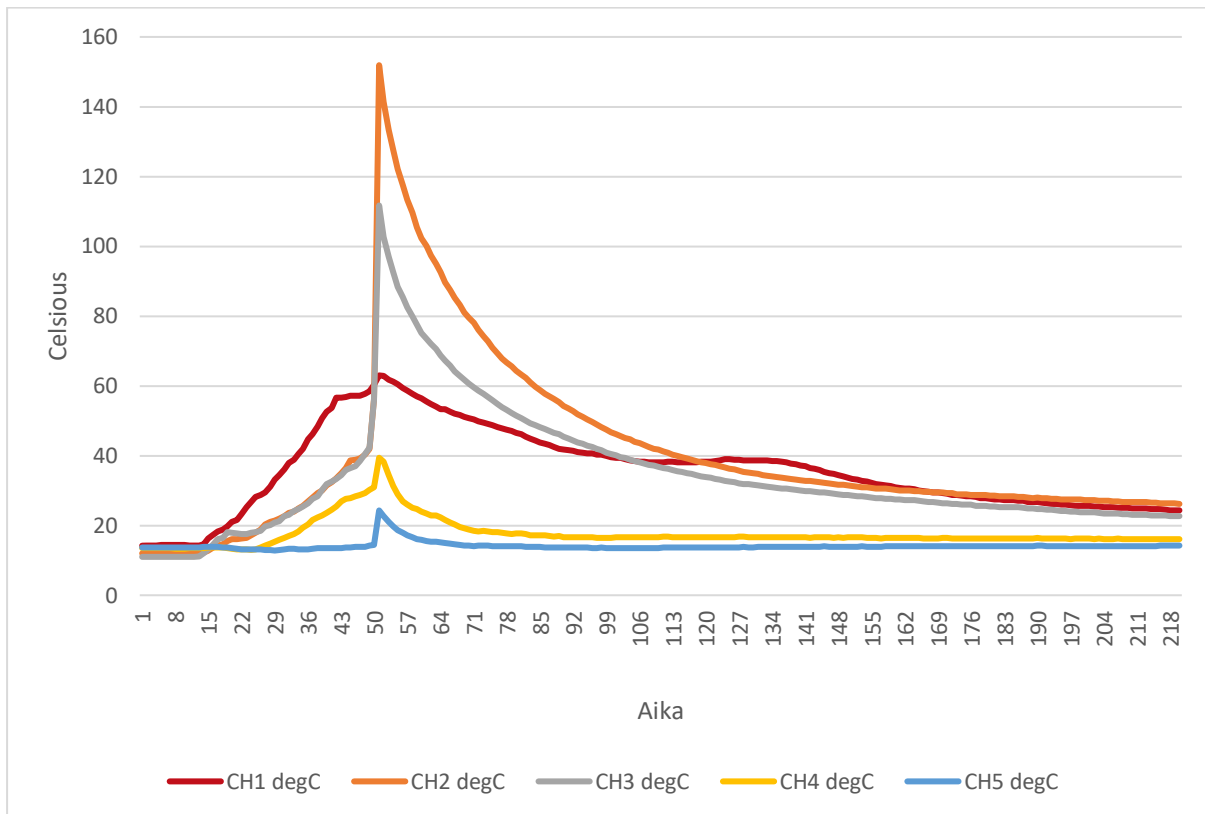


Figure 12. Channel temperatures °C.

During the test, the highest temperatures were measured in channels 2 (150°C) and 3 (110°C). At other measurement points, temperatures did not rise significantly.



6 Results: Gas measurements

6.1 Test 1, RadEX 15 without fire

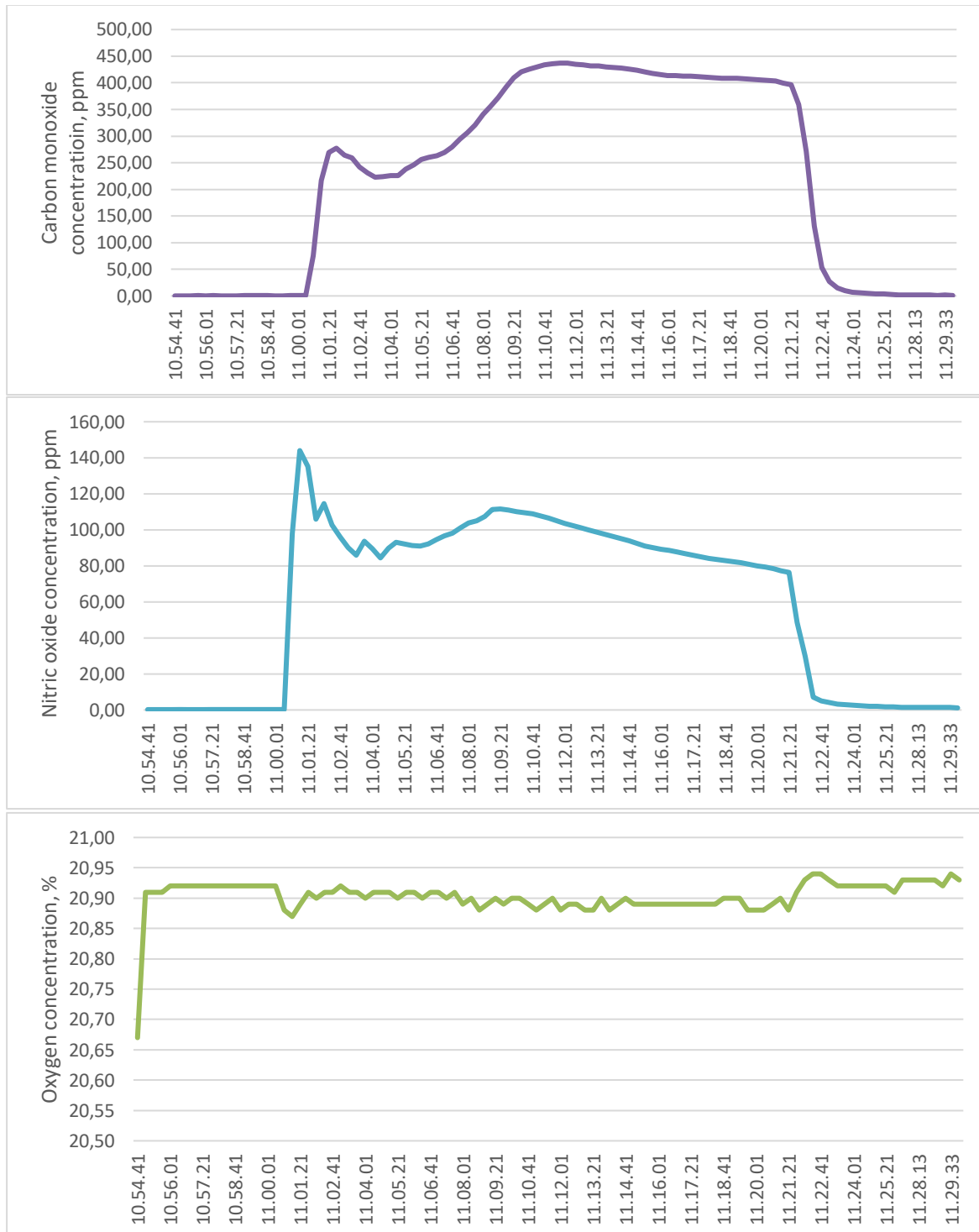


Figure 13. Carbon monoxide, nitric oxide and oxygen concentrations.



6.2 Test 2, RadEX 20 without fire

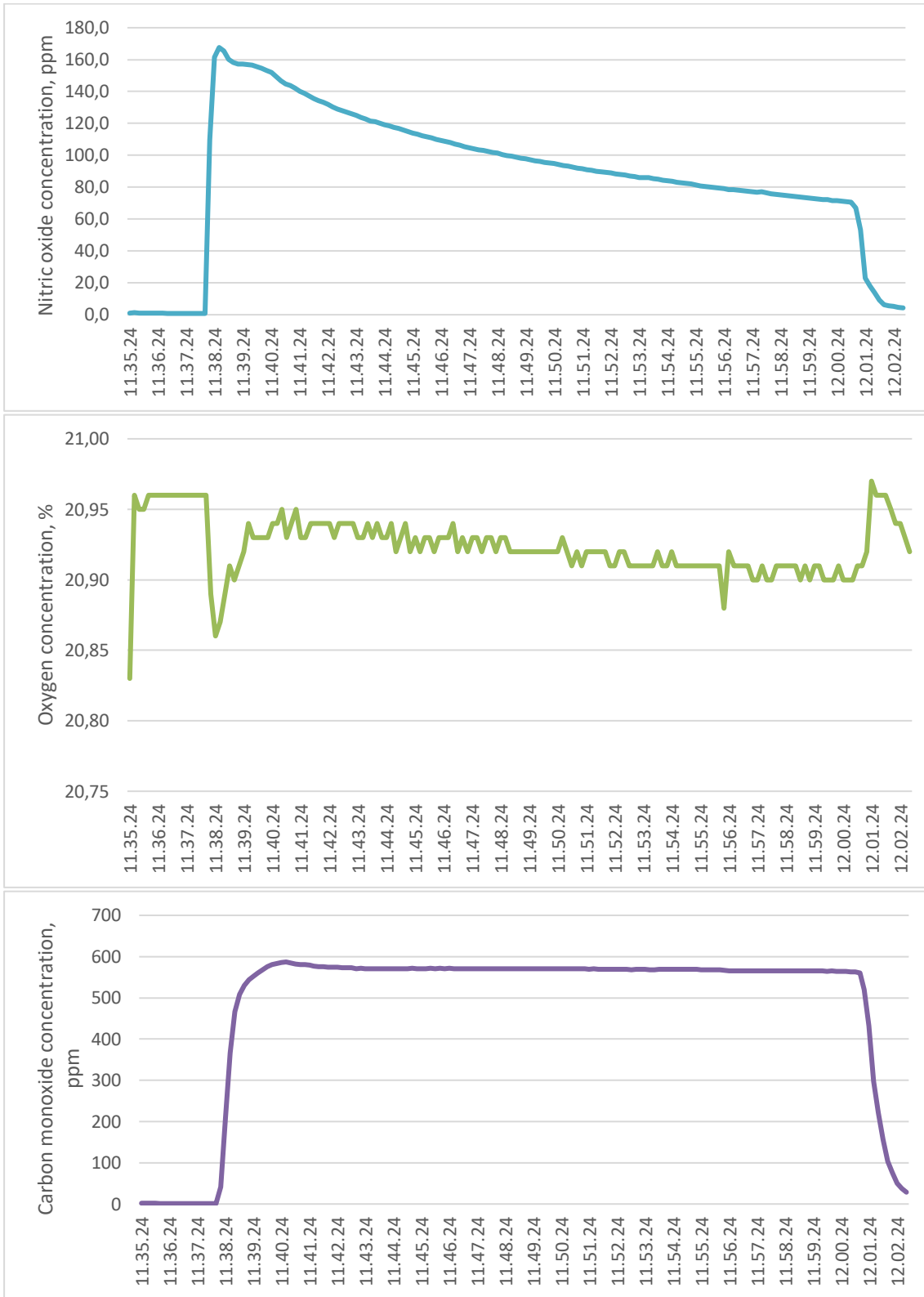


Figure 14. Carbon monoxide, nitric oxide and oxygen concentrations.



6.3 Test 3, Product X without fire

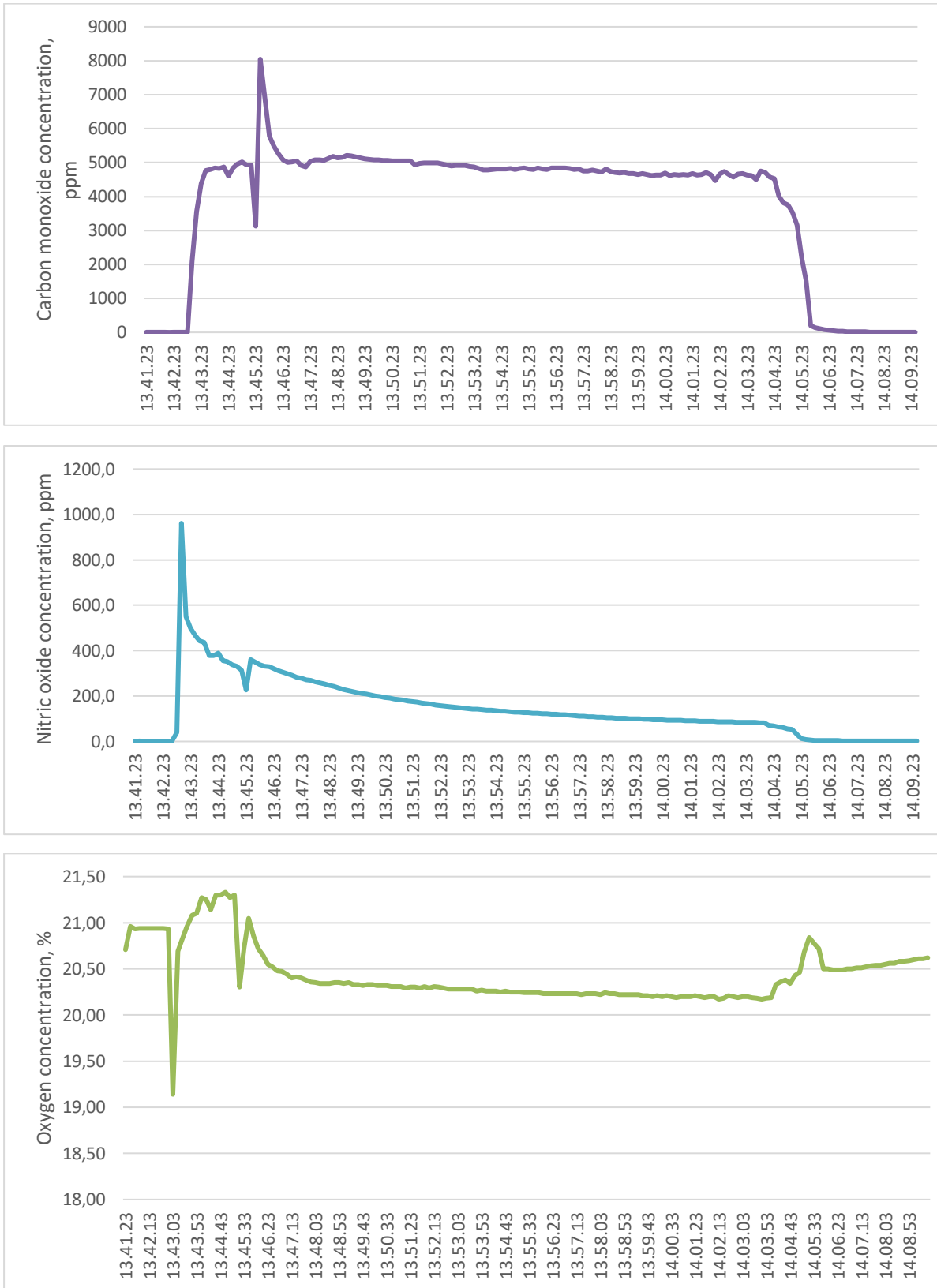


Figure 15. Carbon monoxide, nitric oxide and oxygen concentrations.



6.4 Test 4, Product X with fire

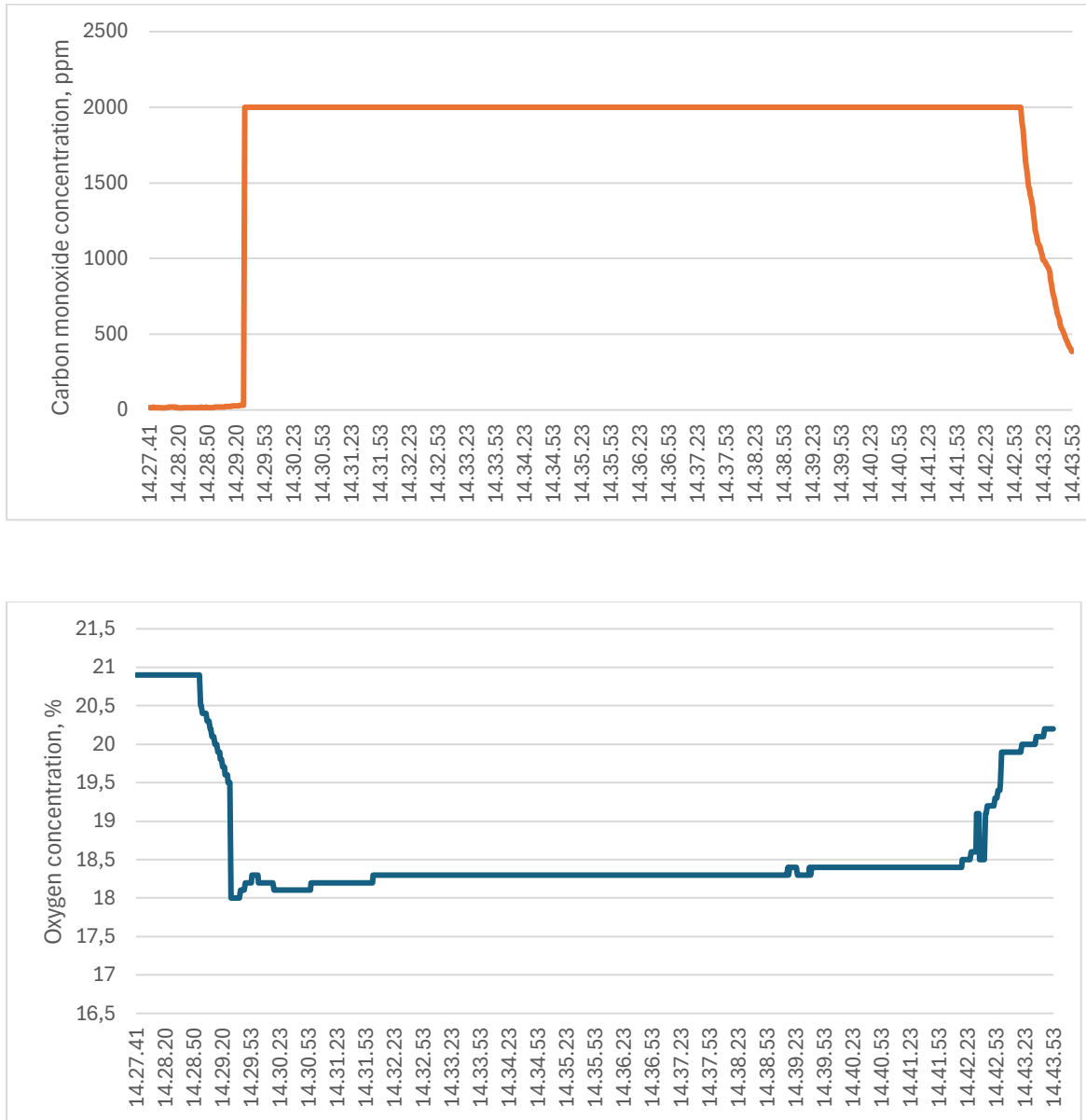


Figure 16. Carbon monoxide and oxygen concentrations.



6.5 Test 5, RadEX 20 with fire

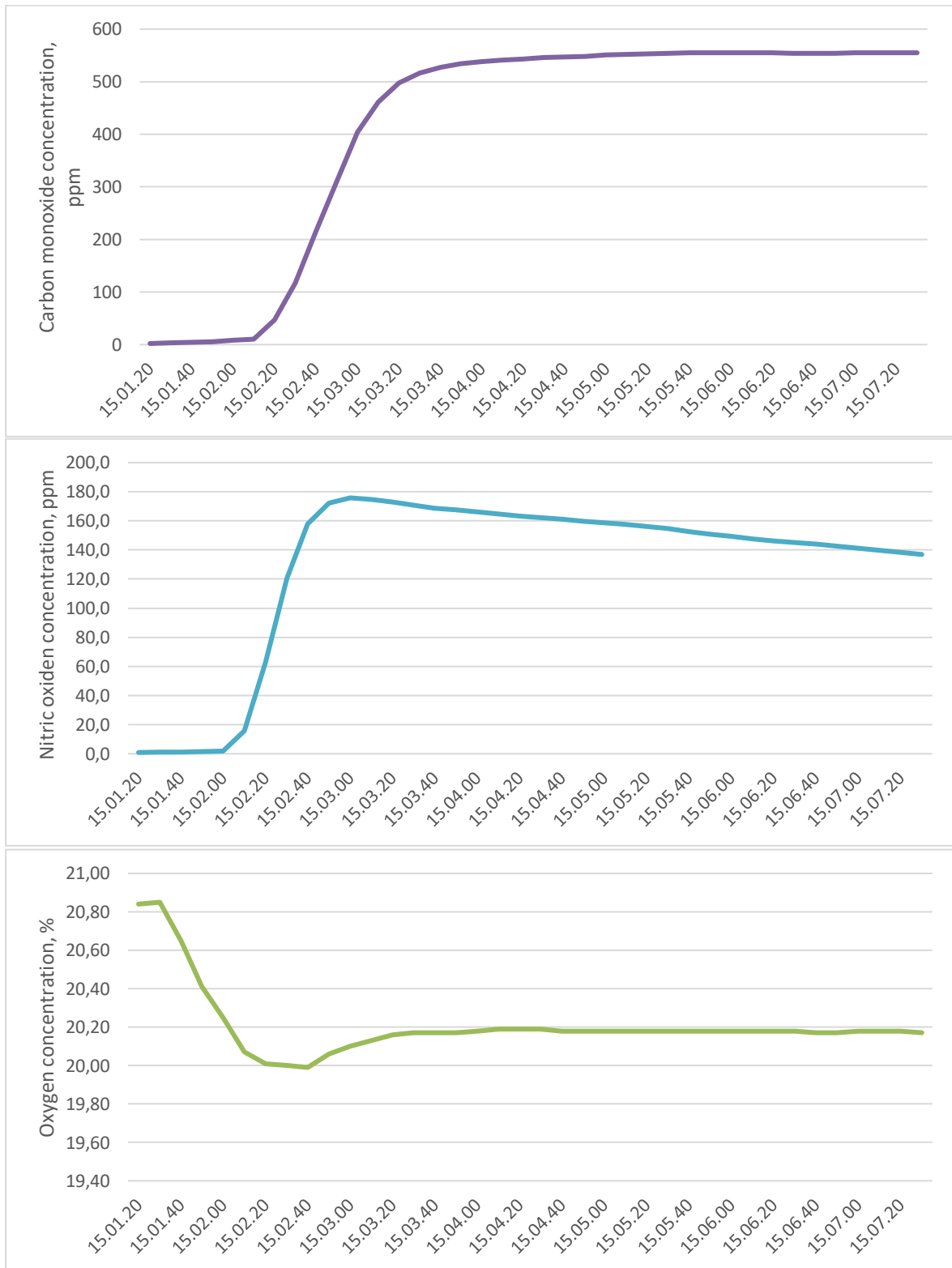


Figure 17. Carbon monoxide, nitric oxide and oxygen concentrations.



6.6 Test6, RadEX 15 with fire

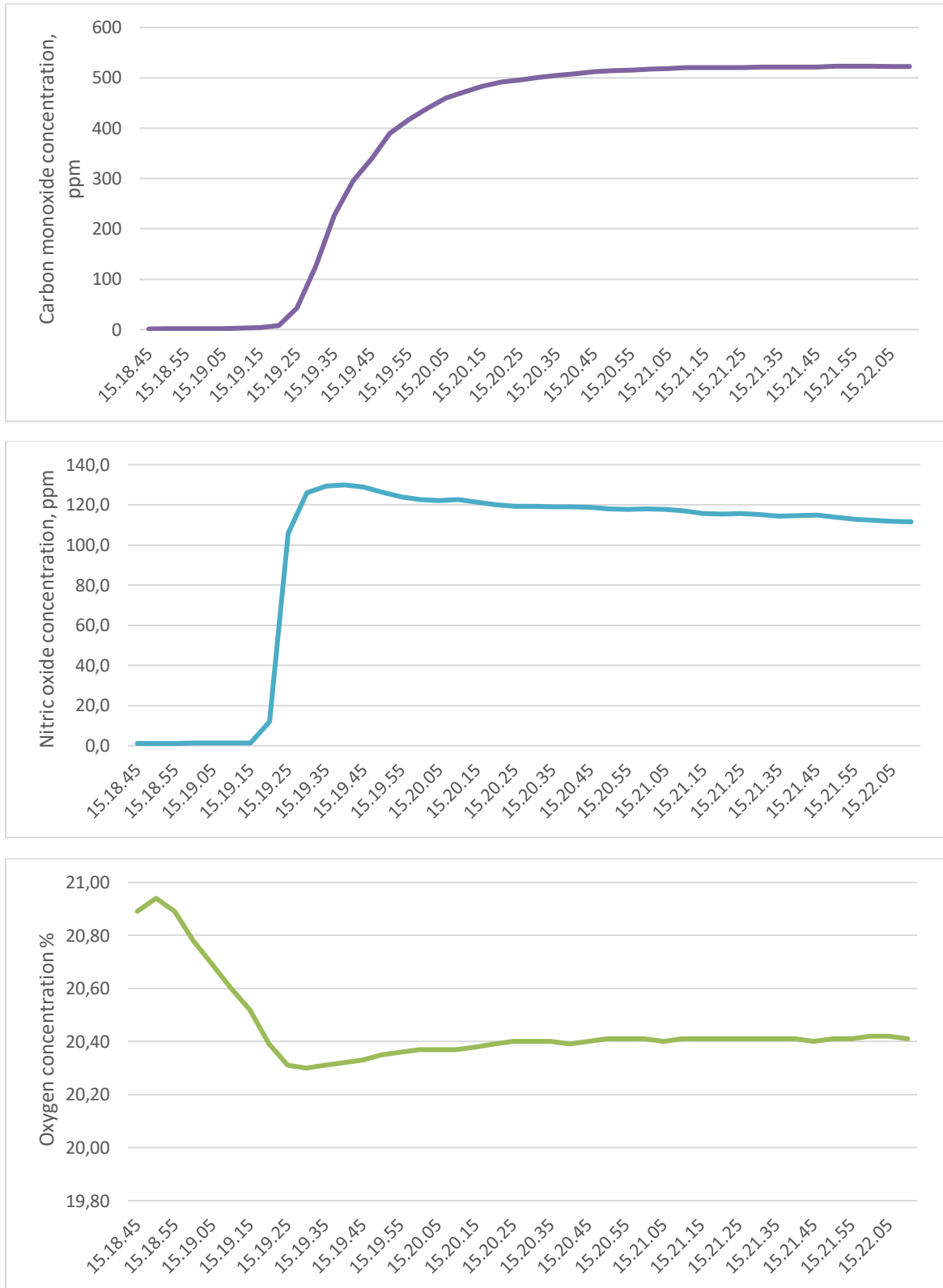


Figure 18. Carbon monoxide, nitric oxide and oxygen concentrations.

7 Results: Aerosol Measurements

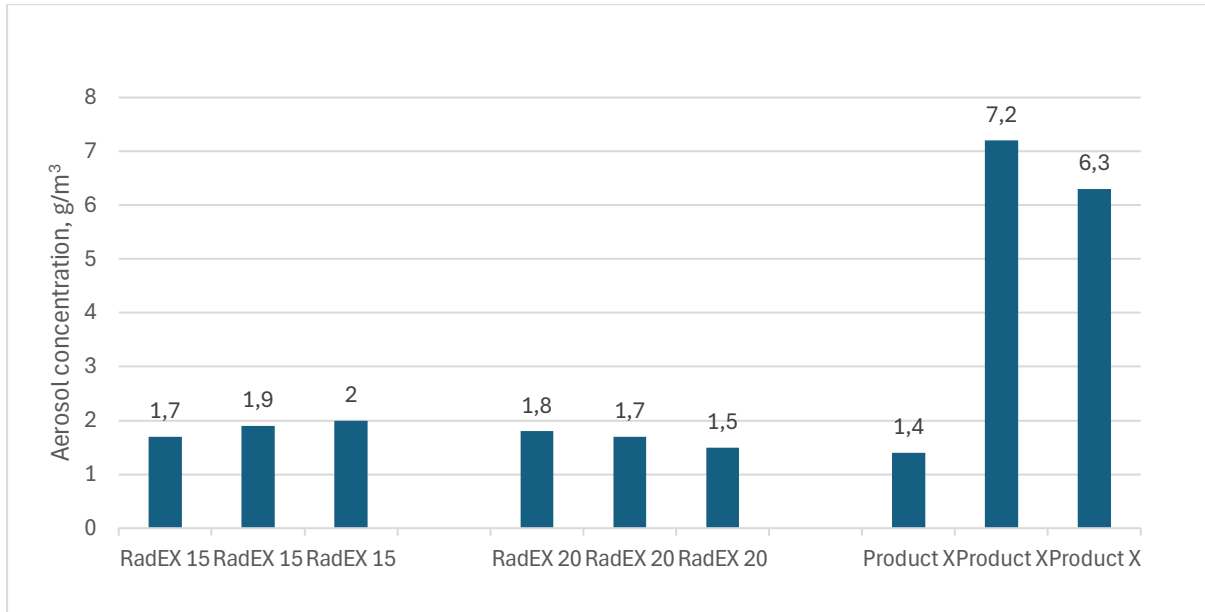


Figure 19. Aerosol concentrations following the product's discharge with different fire extinguishers without flame.

8 Discussion

8.1 Temperatures

According to commonly known fire properties, the thermal softening of dry wood begins at a temperature of about 180°C and the wood ignites at 250–300°C.

In the tests of the RadEX fire extinguisher in the immediate vicinity of the nozzle, the temperature increases after firing were moderate and short-lived. According to the measurement results, only in test no. 1 has the temperature been above 250°C for eight seconds 200 mm from the nozzle. (Figure 7-10) Remarkably, the lighter used to ignite this prototype caused open flames, sparks, and high temperatures. This laboratory prototype uses an atypical ignition method, so the phenomenon should not be considered representative of the RadEX product.

The temperatures of the product X were also very low.

8.2 Gas and aerosol concentrations

Carbon monoxide concentrations when using RadEX 15 and 20 products peaked at 440–590 ppm following the discharge without fire (Figures 13 and 14). With fire, the concentrations ranged from



520 to 550 ppm (Figures 17 and 18). The carbon monoxide concentrations of the product X without fire were over 8000 ppm (Figure 15) and with fire over 2000 ppm (Figure 16).

Nitric oxide concentrations with RadEX 15 and 20 products peaked at 140–170 ppm following the discharge without fire (Figures 13 and 14) and 130–180 ppm with fire (Figures 17 and 18). With the product X, the nitric oxide concentrations without fire were 960 ppm (Figure 15), but the measurement with fire failed due to malfunction of the flue gas analyser.

Oxygen concentrations with RadEX 15 and 20 were at their lowest following the discharge at 20.9% without fire (Figures 13 and 14). With fire, the lowest concentrations were 20–20.3% (Figures 17 and 18). With the product X without fire, the oxygen concentrations were at their lowest at 19.1% (Figure 15) and with fire at 18% (Figure 16).

Aerosol concentrations in chamber air when using RadEX 15 and 20 products were 1.5–2 g/m³ following the discharge without fire (Figure 19). The aerosol concentration in the air of the product X following the discharge was 1.4–7.2 g/m³.

9 Conclusions

Temperature measurements showed that the highest temperatures in the vicinity of aerosol extinguishers were close to the ignition temperatures of the wood, but the prototype did not have a cooling mechanism.

The carbon monoxide concentrations of RadEX products were clearly below the IDHL value of carbon monoxide following the discharge. The concentrations of the product X were at their highest 6.7-fold higher than IDHL-value for carbon monoxide.

Nitric oxide concentrations with RadEX 15 and 20 products following the discharge were at their highest 1.4–1.8 -fold higher compared to the IDHL value of nitric oxide. The concentrations of the product X were at their highest 9.6-fold higher than IDHL value for nitric oxide.

The oxygen concentrations were slightly lower for the product X, but neither following the discharge did not fall below occupational exposure limit value of oxygen (18%).

The aerosol concentrations of RadEX products were 150–200 times higher than the Finnish occupational limit value for inorganic dust. The concentrations of the product X were 140–670 times higher than occupational exposure limit value for inorganic dust.



10 References

Ministry of Social Affairs and Health (2025). HTP values 2025, concentrations known to be harmful. Publications of the Ministry of Social Affairs and Health 2025:4. Helsinki. https://julkaisut.valtioneuvosto.fi/bitstream/handle/10024/166151/STM_2025_4_J.pdf?sequence=1&isAllowed=y

NIOSH (2021). Immediately Dangerous to life or Health (IDLH) values. <https://www.cdc.gov/niosh/idlh/intridl4.html>

EPA (2024). About Acute Exposure Guideline Levels (AEGs). <https://www.epa.gov/aegl/about-acute-exposure-guideline-levels-aegls>