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Ehningen: Fire of a high-voltage battery on a test stand

Fast extinguishing success with F-500 - Interesting extinguishing water analysis

A high-voltage car battery burned on an air-conditioning test bench in Ehningen (Baden-Württemberg). The fire was quickly extinguished by the emergency services with the extinguishing agent additive F-500. The article describes the course of action and deals in particular with the topics of extinguishing water retention and extinguishing water analysis.

On Whit Monday, June 1, 2020, a high-voltage car battery caught fire in a climatic chamber of a high-voltage battery testing center in Ehningen (Böblingen district/Baden-Württemberg). The difficult handling of the high-voltage car battery, which is still in the development stage, and the rapid thermal treatment of the battery block resulted in a large-scale firefighting operation.

Cold position

The municipality of Ehningen, with around 9,200 inhabitants and an area of just under 18 square kilometres, is located in the district of Böblingen. Due to its central location in the district, only a few kilometres south of Böblingen and only about 18 kilometres south of the state capital Stuttgart, as well as the connection to the motorway, Ehningen is an ideal place to live.

81 and to the S-Bahn of the Stuttgart region, several large international companies have settled in the municipality with their headquarters and production units.

The Ehningen Volunteer Fire Department has 69 volunteer firefighters and one technical firefighting employee. They have a TLF 16/25, an aerial work platform (HAB) 23, an LF 16/12, an ELW 1, a MTW and a GW-Transport at their disposal. The fire brigade is called out to about 70 operations per year.

On the day of operation, the weather was sunny with a maximum temperature of 22 °C. A light wind was blowing from westerly directions.

The object of operation

The company Bertrandt Technikum GmbH

The local company offers a wide range of development services and is one of the leading engineering companies in the world. A high-voltage battery test centre with an area of 1,300 square metres is also operated on the company premises. In the building, high-voltage batteries from the module level to hybrid batteries and batteries for purely electrically powered vehicles can be tested and functionally validated under various climatic and load conditions.

In the building of the high-voltage battery test center, there are six test rooms for high-voltage batteries, each of which contains two 16-square-meter climate chambers with up to four high-voltage channels. In total, the high-voltage battery test centre has a test room volume of 192 cubic metres and a high-voltage test capacity of 9,600 kilowatts. The high-voltage channels can be coupled together to simulate particularly high outputs of up to 1 600 kilowatts. The climatic chambers



left: Overview of the operation site. Climate chamber 12 is located in the building on the far left (outside the picture). The liquid-tight roll-off trough is next to the company entrance. **right:** View of the climatic chamber 12 affected by the fire with the C feed fitting.



have a temperature range of -40 to +120 °C. Furthermore, there are a total of four machine rooms in which 24 battery testers are arranged, each with an output of 400 kilowatts, a voltage of 1,200 volts and currents of up to 1,000 amperes.

During the construction of the high-voltage battery test center, the company placed particular emphasis on fire protection and the corresponding safety concept - in some cases, the requirements of preventive fire protection were significantly exceeded, even in consultation with the local fire department. The safety concept is designed to ensure that critical processes in the battery test are detected at an early stage and that fire prevention or defence can be initiated as quickly as possible. It takes into account operation up to Hazard Level 4 (of seven hazard levels) in accordance with EUCAR (European Council for Automotive R & D), where these hazard levels only apply to faults in the battery.

battery cells, but not electrical safety. The latter is monitored and ensured by the test bench. The test rooms are only populated during testing; the battery store is not located in the building.

The test rooms are structurally separated from each other in a fire-retardant manner, as are the rooms for supplying energy to the test rooms. All rooms are accessible from the outside via doors or gates. In case of fire, the climatic chambers can be flooded with extinguishing agent via external C-feeding devices. A sudden pressure increase ("blow off") inside the test chamber is intercepted by a bursting diaphragm. The excess pressure is discharged to the outside via an additional air duct.

The test building is monitored by the company's fire alarm system. Furthermore, a fire brigade plan in accordance with DIN 14095 is available to the emergency services. The extinguishing water supply is

via DN100 underground hydrants in the public road area or via the extinguishing pond on the company premises, which holds around 800 cubic metres of water and also serves as a retention basin for the surface water.

To retain extinguishing water, the high-voltage battery test centre can be separated from the company inlet channel to the extinguishing pond by means of a gate valve; a structural collection volume of five cubic metres is available upstream of the gate valve. The surface water inlets on the company premises can be closed by means of manhole covers provided on site.

For battery disasters, the company keeps a liquid-tight container on the company premises in which the batteries can be stored temporarily.

Operation procedure

On June 1, 2020, Integrier alerted...

- Display



neuruppin

Exclusive partner of F-500 EA for active fire protection in the temperature range -30 to +60°C with products "MADE in Germany"












Left: The extinguishing agent mixture was first collected in the underground structural five-cubic-metre collection tank ... **right:** ...and then pumped into the company's liquid-tight roll-off container (here during preparation for the pumping work).

Böblingen control centre called the Ehningen fire brigade at 16.10 hrs with the keyword "fire".

»Brandmeldeanlage« zum Hochvoltbatterie-Prüfzentrum. Aufgrund der damals gültigen »-Corona-Alarm- und Ausrückeordnung« wurde zunächst nur ein Zug der Feuerwehr alarmiert (bei einem Einsatz infolge einer Brandmeldeanlage rückte nur ein Löschfahrzeug mit Staffelbesetzung aus). So rückten der ELW 1 (Besatzung: 1/1) und das LF 16/12 (1/5) aus, die um 16.16 bzw. 16.18 Uhr an der Einsatzstelle eintrafen. Bereits während der Anfahrt war eine Rauchentwicklung aus dem Hochvoltbatterie-Prüfzentrum wahrnehmbar. Während der ELW 1 zunächst die im Hauptgebäude des Betriebes befindliche Brandmelderzentrale anfuhr, wurde das Löschfahrzeug direkt zum Prüfzentrum dirigiert. An der Brandmelderzentrale wurde die BMA-Auslösung in der Klimakammer 12 des Hochvoltbatterie-

test centre was confirmed. The first investigation of the head of operations with the safety service of the company confirmed this impression: The smoke development originated from the broken bursting disk of the exhaust chimney of the climatic chamber 12. Parallel to the investigation, the TLF 16/25 (1/5) was requested and at 16:27 o'clock full alarm was triggered for the fire brigade Ehningen.

As part of the low-damage tactics, the extinguishing attack was selected from the outside through the outer doors of the test room. It was no longer possible to explore the test room without breathing protection. Two breathing protection teams located the source of the fire as a burning high-voltage car battery in the climatic chamber 12.

The extinguishing operation was carried out directly via the C feed device on the outside of the test chamber. In this way, the climatic chamber and the

The high-voltage battery, whose housing was completely closed, was flooded. Water with a three-percent admixture of the extinguishing agent additive F-500 was used as the extinguishing agent. Within one minute a successful extinguishing could be achieved and the feedback "fire under control" could be given. An immediate decrease of the temperature in the climatic chamber by about 75 °C to 190 °C as well as a further decrease to about 160 °C within ten minutes could be observed.

Parallel to the extinguishing measures, the two external roller shutters of the test stand room were opened and smoke extraction was initiated by means of a pressure ventilator. The acknowledgement "fire out" was given at 17:37 hrs.

Extinguishing water reChAltion

As the climatic chamber installed in the test room could only withstand the water pressure to a limited extent as a result of the extinguishing and subsequent further cooling measures despite additional constructive measures, water leaked from the doors of the climatic chamber. It was assumed that the water had been contaminated by hydrofluoric acid, so that the responsible southern environmental protection platoon of the Böblingen district fire brigades was alerted at 16.51 hrs. At the same time, the command called for a change of clothing for the firefighters contaminated by smoke or extinguishing agents.

In the meantime, in addition to the fire-fighting section also the operation section „extinguishing Water...



Parts of the environmental protection platoon south in the staging area at the scene of the incident

Organization	Vehicles	Forces
FF Ehningen	ELW 1, LF 16/12, TLF 16/25, GW-T, MTW	32
Environmental Protection Platoon-South	Fw. Böblingen: ELW 1, HLF 20, WLF with AB-Gefahrgut, GW Decon-P; FF Herrenberg: ABC-ErkKw, WLF with AB-Umwelt, LF 8, TLF 24/50, RW Fw. Sindelfingen: WLF with AB-Respiratory protection	41
Fw. Böblingen	ELW 2 (with command group)	9
WF Mercedes-Benz, Sindelfingen	WLF with AB platform	2
Consultant Chemistry		1
Rescue Service		7
DRK local associations Eh-ningen, Aidlingen		13
THW		2
Police		6
SUM		113

retention", which was led by a platoon leader, had been set up. During the investigation it quickly became clear that the existing structural collection solution with a capacity of five cubic metres would not be sufficient. As an alternative, it was planned to pump the collected extinguishing agent mixture into the company's liquid-tight roll-off trough. After the arrival of the environmental protection platoon at 5.24 p.m., the unit was assigned the following tasks:

- Pumping of the extinguishing agent mixture from the catch basin into the liquid-tight roll-off trough,
- Recovery and securing of the high-voltage battery,

- Construction and operation of a decontamination site.

The coordination of the operation was now carried out by the ELW 2 of the district with the support of the management group and the chemical advisor.

The forces of the environmental protection platoon pumped the extinguishing agent mixture from the five-cubic-meter catch basin into the roll-off trough. A total of seven cubic metres of extinguishing agent mixture was involved.

Immediately after arriving at the scene of the incident, the forces of the environmental protection platoon investigated the situation on site. This also included obtaining information about hydrogen fluoride.

(UN 1052, CAS 7664-39-3). For fluorine For hydrogen fluoride, the Acute Expose Guideline Levels (AEGL) is 1.0 ppm, the Operational Tolerance Level (ETW-4) is 12 ppm, and a chemical protective suit is recommended as personal protective equipment. Hydrogen fluoride cannot be detected with the photoionization detector of the environmental protection train.

Battery recovery

While the measures initially focused on collecting and pumping over the extinguishing agent mixture, the salvage of the damaged high-voltage battery later became the focus of attention. The high-voltage battery could only be disconnected at the test stand at 6.31 pm. From

At 7.30 p.m., the emergency services secured the extinguished battery in a recovery container filled with a water-F-500 mixture at the Mercedes-Benz Sindelfingen plant fire brigade, into which it had been moved by means of a forklift truck. The work took about half an hour. The battery did not ignite again. The work was carried out under chemical protection suits.

Due to the long course of the operation, the "Supply and Care" operation section was set up as a third operation section.

Cause of fire

The high-voltage car battery had suffered a thermal runaway. The company had evaluated the recorded test bench data and found out that within three days there had been a thermal runaway.



Left: With a WLF, the WF Mercedes-Benz brought a battery salvage container. **right:** By means of a forklift truck, the damaged battery together with the carrier frame was brought into the salvage container.



Decon station at the operation site

The temperature in the battery cells had risen continuously to around 70 °C due to a defective bearing. Shortly before the fire, there was a sudden massive rise in temperature in the climatic chamber to around 265 °C. The temperature in the climatic chamber had risen to around 70 °C. The temperature in the battery cells had also risen. Metal particles from the battery had previously hit the ceiling of the climatic chamber, got stuck there and melted into the chamber ceiling.

Extinguishing water analysis

Already during the course of the operation, the task forces of the environmental protection unit took the first measurements at 7:38 p.m. with pH indicator paper in the catch basin. The measurements showed a neutral pH value of 7.

Both the extinguishing agent mixture from the five-cubic-metre catch basin and from the liquid-tight roll-off trough were tested four days after use by a recognised testing institute in accordance with the specifications of DIN 38407-39.

"German standard procedure for water, waste water and sludge analysis

- Commonly detectable groups of substances (Group F) - Part 39: Determination of selected polycyclic aromatic hydrocarbons (PAHs) - Method using gas chromatography and mass spectrometric detection (GC-MS)". In addition to the pH-value and the polycyclic aromatic hydrocarbons (PAH), the focus was also on metal compounds. The limit values according to the drinking water ordinance were used as the determination limit (0.01 µg/l PAH).

Based on the laboratory results, the company concerned had an external expert draw up a disposal concept: According to this, the extinguishing water mixture could be discharged into the sewage treatment plant on the basis of the values. It is particularly important for the fire brigade that the laboratory also confirmed the pH measurement of the emergency services with a pH value of 7.2 and that no hydrofluoric acid could be detected in the extinguishing agent mixture.

Conclusion

From the point of view of the Ehningen volunteer fire brigade, the conclusion of the operation is very positive: the unusual situation was quickly controlled and, with the exception of a minor abrasion, there were no injuries. In particular, the material damage could be limited to the affected climatic chamber, which is also important for the company. Both the rapid success in extinguishing the fire and the limitation of the material damage are due on the one hand to the exemplary measures taken by the firefighters.

The company's fire prevention and hazard protection measures, which went beyond the requirements of building law, were also achieved by the rapid use of the extinguishing agent additive F-500. According to the head of operations, the use of F-500 resulted in rapid cooling and thus prevented the spread of fire, even though the extinguishing agent only reached the outside of the intact battery housing (and thus not the battery cells themselves). Particularly praiseworthy is the company's transparent handling of the event and the findings of the operation - an example that creates trust and also allows the fire brigades to share the findings.

One tactical question is still unresolved: Based on the experience gained during this operation, will the environmental protection platoon have to be alerted again in the event of future incidents, or will it be sufficient to alert a decontamination unit? III

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Pictures: FF Ehningen