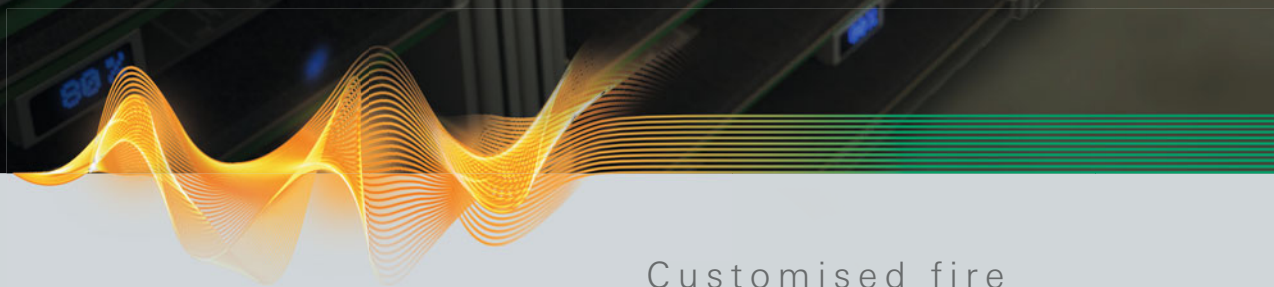


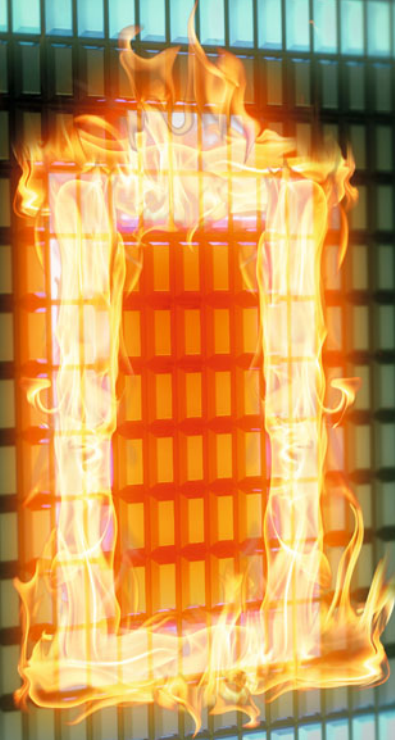


POCKET-SIZE / HIGH PERFORMANCE
POWER DEVICES REQUIRE ADVANCED
FIRE PROTECTION SOLUTIONS.



Customised fire
protection solutions
for lithium batteries

FULLY CHARGED. IS YOUR FIRE PROTECTION STILL IN CHARGE?



The applications for lithium batteries are practically unlimited. But what happens when these powerful energy storage devices trigger a dangerous chain reaction and start a fire on their own?

Lithium batteries have been gaining ground for years. The “National Development Plan for Electrical Mobility”, released by the German government, sets out plans for Germany to become the leading market in electrical mobility – the plan is to have one million electrical vehicles on the German roads by 2020. Lithium batteries are also used in a large number of other applications, such as energy storage, and are now a firmly established part of everyday life.

Different battery types

Today there is an almost endless variety of lithium battery types – for a wide range of applications and technologies i.e. cathodes, anodes and electrolytes with differences in their construction, power and size (e.g. lithium-metal, lithium-ion, lithium-polymer). “Lithium battery” is a collective term for the wide variety of battery systems containing lithium in its pure or compound form as an active material in the battery electrodes. The large number of possible combinations of individual components also creates a complex picture of potential safety risks and hazards.

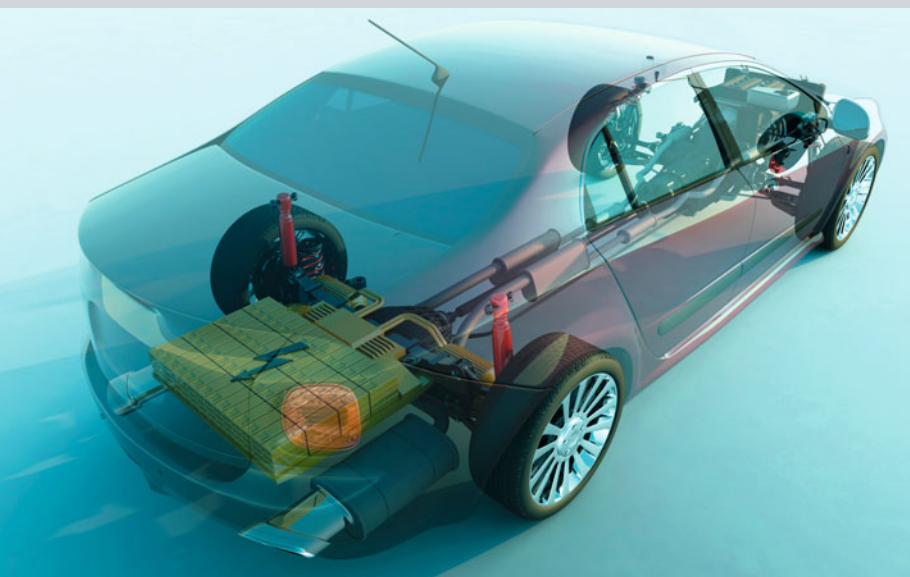
Lithium batteries for many different applications

In particular, the boom in small mobile electronic applications (Smartphone’s, notebooks, cameras, tools etc.) has led to the spread of lithium batteries on a massive scale. Lithium batteries are also gaining importance in the small vehicles segment (in motors for bicycles, scooters, lawnmowers, forklifts etc.). Lithium batteries have exploded onto the scene in the automotive industry (hybrid drives, high-voltage electric drives etc.).



Dr. Michael Buser
Managing Director
Risk Experts
Engineering GmbH

“Although we can generally assume that lithium batteries are relatively safe when they are handled correctly and used properly, these “pocket-sized powerplants” bring specific risks which present special challenges for the safety of people, and in particular for technical fire protection.”



CHARGE LEVEL: FULL.

RISK: VERY HIGH.

REAL FIRE PROTECTION: NONE.

There are a number of different risks associated with the use of lithium batteries. A number of incidents in the past have proven the importance of custom designed fire protection solutions.



The introduction of electric drives will be one of the major trends on the road to sustainable mobility in the automobile industry. However, due to the wide range of new applications, there are also many risks involved in the use of lithium batteries. Incidents in recent years have shown that the demands for the right type of fire protection is extremely high.

Numerous risks

Lithium batteries store large amounts of energy. It is possible that technical defects or incorrect handling could cause chemical energy stored in the battery to be released in an uncontrolled and accelerated manner. This energy is generally released as thermal energy. Inevitably causing a short-circuit, and as a result, a fire. Mechanical damage, electrical faults or thermal effects can lead to leaking electrolyte, fire or explosion.

Lithium batteries as the cause of damage

The fire risk represented by lithium cells cannot be underestimated.

This has already been confirmed by many examples of fire scenarios. There have recently been several incidents. In 2012, a major fire destroyed a warehouse storing over 10,000 electric bicycles. A few years ago, the production and storage facility of a battery assembly centre burned to the ground. There have also been some serious aviation accidents. In September 2010, a UPS freight aircraft (Boeing 747) crashed in Dubai with a large number of lithium batteries in the hold. In July 2011, there was a plane crash in South Korea. The aircraft belonged to Asiana Airlines and was carrying a shipment of lithium batteries on board.

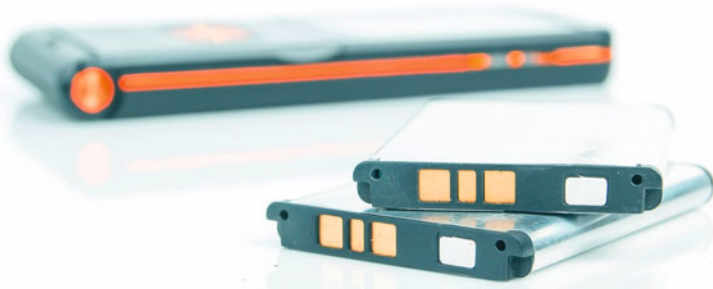


THE RISK IS HIGH.
IN PRODUCTION AND LOGISTICS.
A CHAIN REACTION CAN DESTROY THE IRREPLACEABLE.

The demand for battery cells will continue to grow over the years to come, as will the fire protection demands. WAGNER has the right fire protection solution for your needs.



There are different classes of lithium batteries. These include batteries with low, medium and high power. WAGNER specialises in the development of fire protection solutions for high power lithium batteries. There are already initial insurance relevant recommendations in this category for technical fire protection solutions. This is also the result of numerous serious fires, which have highlighted the need for specialised fire protection.



Risks during lithium battery production

The production of a lithium battery is a chemical and mechanical process. Once the cells are manufactured, they are subjected to electrical testing. Formatting, i.e. the initial charging process activates the electronic storage cell, which then becomes an energy store. The energy-hungry process involved in the production of lithium batteries involves high risks, and in the worst case scenario, can lead to a fire. Possible risks may be: thermal runaway due to an internal short-circuit, leaking electrolyte or overcharging. The next process is called aging, the natural aging of the individual cells for several days under various temperature profiles.

Actual fire testing in collaboration with VdS Schadenverhütung (Germany)

WAGNER has focused intensively on the process of cell production and has carried out numerous real fire tests in a storage system for lithium cells in collaboration with VdS and a battery manufacturer. The aim was to prevent a fire from

spreading to neighbouring cells. Fire behaviour was analysed in great depth, facilitating the development of a comprehensive and customised fire protection concept based on these results. The extremely tight spacing conditions and the high packing storage density in the warehouse were taken into account in the analysis process.

Fire protection systems for transport

The majority of lithium batteries is produced in Asia. Consequently the transportation process is extremely complex. At least a third of batteries are transported by air. Recently this has led to a number of air traffic incidents associated with fires. Over the past 10 years, FAA, the Federal Aviation Administration in the USA, has recorded 121 incidents (including plane crashes) involving batteries. A major share is caused by lithium batteries. WAGNER has already tackled this subject in depth and is involved in the design of fire protection systems for air travel. Numerous fire tests have also been performed in this area.

WAGNER fire protection systems for aviation can also be used for rail transportation.

Risks associated with the storage of lithium batteries

As for the storage of lithium batteries, there is still no knowledge or experience regarding the effectiveness of existing fire protection systems when a fire actually starts. This leads to great uncertainty for the insurance industry. For this reason, the insurance industry has specified the various risks in a data sheet Technical Bulletin and has defined actions and measures to prevent damage. For this purpose, batteries are classified into different categories according to their storage capacity and safety regulations defined for their storage (storage height, number, clearance, separation, etc.). For example, the mixed storage of medium (and high) power batteries with other products is not permitted. German insurance industry recommends special fire protection solutions for high power lithium batteries.

THE ENERGY COMES FROM THE STORAGE DEVICE.
BUT THE FIRE PROTECTION IS NOT OFF THE SHELF.
THIS IS WAGNER.

A fire protection system for protecting the operation and recycling of lithium batteries must be perfectly customised to fit the risk's needs.



Lithium batteries require an extremely high safety level. The use of batteries involves a considerable number of risks. There is still no conclusive clarification of the risks involved in their return and recycling, and these appear to be extremely high. In general, the production (formatting, aging), logistics, operation and disposal of the cell types must be protected by reliable fire protection systems.

Risks associated with the use of lithium batteries

According to a DEKRA study on "Safety in Electric Vehicles", electric cars with lithium drive batteries are at least as safe as conventional drive systems in the event of a fire. This is the result of a current series of fire tests which have been carried out by DEKRA officials in conjunction with an automobile manufacturer. Risks are much more likely to be found in peripheral areas. Thus for example test benches for batteries and electric motors must be protected using appropriate fire protection measures. There is a risk that the batteries may burst if the load is too high or a production error, which could result in the ignition of the mixed gases.

Charging stations pose a risk

An additional risk is posed by the charging stations for lithium batteries. Defects in the plug connectors or overcharging can quickly lead to a fire. These are typical electrical fires with an extended pyrolysis phase. Reliable very early fire detection is here an absolute necessity. Charging stations are very often located in underground car parks. Fire protection systems with extremely high false alarm immunity are indispensable in these areas.

Risks involved in the return and recycling of lithium batteries

Today everyone is talking about the spread of electrical mobility. However, how to dispose of used or defective battery systems is



a matter which has yet to be conclusively resolved. The fire risk presented by these batteries is considerably greater since it is not possible to define the condition of the defective batteries. Here, very special fire protection solutions will be needed.

Oxygen reduction is the answer

Insuring risk-free transportation and disposal, especially of high power batteries, is extremely important. The ideal solution for safe transportation of a damaged cell is a reduced oxygen atmosphere. It is impossible for a fire to start in this type of atmosphere. WAGNER is currently developing a solution which renders the transport containers inert (e.g. swap body systems), to prevent a fire from starting.



LOWER RISKS.
HIGHER SAFETY.
FIRE PREVENTION & PROTECTION FROM WAGNER.

The tried and tested TITANUS® fire detection technology and the OxyReduct® fire prevention system form the basis of an optimum fire protection system for lithium batteries.



WAGNER is a pioneer in fire protection of high power lithium batteries and is also been involved in special fire protection in other areas from an early stage. The company has seen and evaluated the risks associated with lithium batteries and has developed appropriate fire prevention and protection concepts. WAGNER is represented in all key standards committees on fire protection of lithium batteries, it is therefore possible to develop customised and personalised fire protection systems, even when no binding specifications or requirements have yet been issued.

TITANUS®:

Because every second counts

In most cases, the basis of a fire protection system is very early fire detection using the TITANUS® air-sampling smoke detection system. This patented and mature technology provides a decisive time advantage when it comes to the protection of people, components and goods. The system has a high level of false alarm immunity, thanks to LOGIC-SENS signal processing and can detect a fire in the initial phase, i.e. before any smoke is visible. Especially in applications such as underground car parks, where many charging stations for electric vehicles are often installed, a reliable very early fire detection system with an extremely high level of false alarm immunity is

essential. The TITANUS® air sampling smoke detection system is ideal for use in the production, transportation, storage and operation as well as the return and recycling of lithium batteries.

OxyReduct®:

Top level fire prevention

Where conventional fire protection systems are pushed to their limits, the OxyReduct® fire prevention system, which is approved by VdS, really comes into its own. The controlled introduction of nitrogen into a protected area permanently reduces the oxygen level depending on the specific environmental conditions. This is highly effective, as in this atmosphere a fire cannot spread to neighbouring cells. This means that the danger-

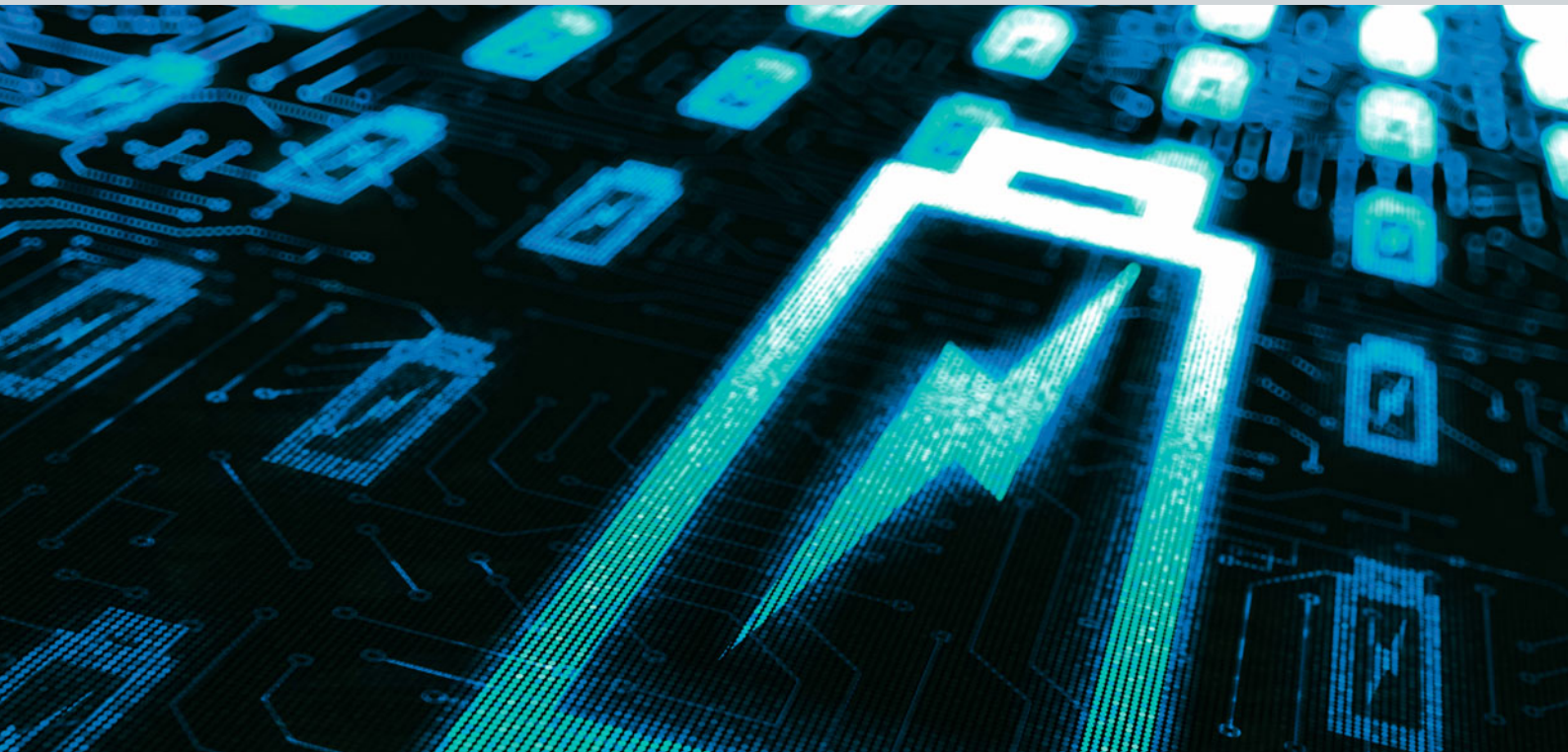


ous chain reaction which rapidly leads to a major fire, will not take place. This has been demonstrated by numerous test fires. The OxyReduct® concept is ideal for processes where fire extinguishing using water would not be feasible, e.g. lithium battery aging process. Combined with a TITANUS® air-sampling smoke detection system, OxyReduct® provides a unique protection concept which is perfect for production, transportation and storage as well as the return and recycling of lithium batteries.



THE BENEFITS ARE CONVINCING.
AND SO IS THE CONCEPT.
CUSTOMISED OF COURSE.

WAGNER offers fire protection systems which are ideal for lithium batteries with its innovative water mist and gas extinguishing technology.



Only when a fire protection solution is customised and personalised for a specific application scenario is it possible to achieve an optimum result. Every application has its specific requirements. This includes lithium batteries, which present specific risks and criteria. It is advantageous to have someone on-board who has been dealing with this subject for many years: WAGNER.



Water mist technology: The three-dimensional extinguishing solution

Wherever a sprinkler is too slow or its extinguishing capacity is insufficient in some specific conditions, the innovative two-phase water mist technology from WAGNER provides an ideal solution. This technology is ideal for use in engine and battery test benches, since unlike other technologies, it has a three-dimensional effect and as a result is able to reach even the tiniest nooks and crannies. These test benches very often have extremely hot surfaces.

Water mist prevents reignition

The use of water mist provides reliable extinguishing and cooling and prevents reignition. WAGNER uses water with no chemical additives, making this technology extremely environmentally friendly. In areas subject to frost, water can simply be heated using a heating element. Fill level measurement is also a standard feature of WAGNER water mist technology. On the

basis of the experience which WAGNER has already gained from fire tests carried out for the protection of aircraft cargo holds, a combination of various technical components is ideal: the rapid and reliable reduction of the oxygen level by the use of a nitrogen extinguishing system in combination with water mist, to boost the cooling effect. The required concentration of the extinguishing agent is maintained by the built-in nitrogen generation system.

FirExting®: With nitrogen for successful fire extinction

The GDV – German Insurance Association Technical Bulletin for Loss Prevention and Risk Management – recommends that high power batteries be stored in fire-proof compartments and that technical fire protection be installed. WAGNER nitrogen extinguishing systems provide the ideal protection for these enclosed areas. Safe storage is provided by rapid and reliable extinguishing.

The right solution for every customer

At WAGNER, we have been developing customised solutions and protection concepts with our customers for many years, perfectly tailored to the respective applications. The know-how from our years of experience in the most diverse areas of fire protection means we are always in a position to offer you the ideal fire protection solution. Our engineers are already working on technologies which will make tomorrow's world a little bit safer and will also protect highly complex scenarios such as the recycling of lithium batteries with the fitting fire protection solution.



UNDERSTAND FIRE.
DEVELOP SOLUTIONS.
THE WAGNER WORLD.

Experience innovative fire protection solutions live in
WAGNER WORLD.

WAGNER



What risks are lurking in production, transportation and storage facilities and in the operation, disposal and recycling of lithium batteries? WAGNER WORLD brings fire protection to life and makes it easier to understand. At WAGNER you can experience technologies today which will become the standard tomorrow. And of course we will provide you with competent answers to all your questions.

Experience state-of-the-art technology

Intelligent, forward-looking fire protection is a complicated subject, which is why we opened the WAGNER WORLD at our headquarters in Langenhagen, Germany, to address unresolved questions and provide concrete answers.

Realistic fire tests

Realistic fire tests are performed in the new laboratories, to demonstrate the combustion behaviour of various materials. Our experts host regular workshops and seminars in

the WAGNER WORLD auditorium to inform our customers, fire protection officers, insurance experts, fire brigades and public authority representatives of current, general and trade-specific fire protection issues.

Putting technology to the test

As a visitor, you can also put our TITANUS® very early fire detection system to the test and experience OxyReduct® in action.

WAGNER – innovative fire protection since 1976

At WAGNER, we have been developing integrated, personalised fire protection concepts for our customers since 1976. We are a trendsetter in the Fire Protection Market with our innovative solutions. We are a full service provider and can provide you with everything you need from support in the design, planning and installation of your fire protection solution to service and support throughout its entire lifecycle. Across the world and wherever you need us.

You can also find us at:

www.wagner.eu





WAGNER sets standards for innovative and comprehensive solutions in fire protection: with very early fire detection systems, TITANUS® for aspirating smoke detection, FirExting® for fire-extinguishing, OxyReduct® to actively prevent fires from breaking out and VisuLAN® for hazard management. www.wagner.eu

Headquarters Sales International

WAGNER Group GmbH

Schleswigstraße 1–5
D-30853 Langenhagen
Germany
Phone +49 511 97383 0
info@wagner.eu

Subsidiaries Worldwide

Austria

WAGNER Austria GmbH

Am Hafen 6/1/12
A-2100 Korneuburg
Phone +43 2262 64262 0
office@wagner-austria.com

Benelux

WAGNER Nederland B.V.

Computerweg 10
NL-3542 DR Utrecht
Phone +31 346 5580 10
info@wagner-nl.com

Great Britain

WAGNER UK Limited

Unit H
Suites 3&4 Peek Business Centre
Woodside, Dunmow Road
Bishop's Stortford
Hertfordshire CM23 5RG
Phone +44 870 333 6116
info@wagner-uk.com

Poland

WAGNER Poland Sp. z o.o.

ul. Puławska 38
PL 05-500 Piaseczno
Phone +48 22 185530 0
info@wagnerpoland.pl

Russia

WAGNER RU GmbH

Businesscentre SMART PARK
117246, Moscow
Nauchnij Projezd
14 A, Building 1, Office 4.12.
Phone +7 495 96767 69
info@wagner-russia.com

Singapore

WAGNER Asia

No. 61 Tai Seng Avenue
#B1-01 Crescendas Print Media Hub
Singapore 534167
Phone +65 6296 7828
info@wagner-asia.com

Switzerland

WAGNER SCHWEIZ AG

Industriestrasse 44
CH-8304 Wallisellen
Phone +41 44 832540 0
info@wagner-schweiz.ch

USA

WAGNER Fire Safety, Inc.

135 Beaver Street #402
Waltham, MA 02452
Phone +1 781 899 9100
info@wagner-us.com