ELECTROMACH STAHL

THE STRONGEST LINK.

HOW TO KEEP HYDROGEN SAFE

Explosion protection for hydrogen solutions

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HYDROGEN

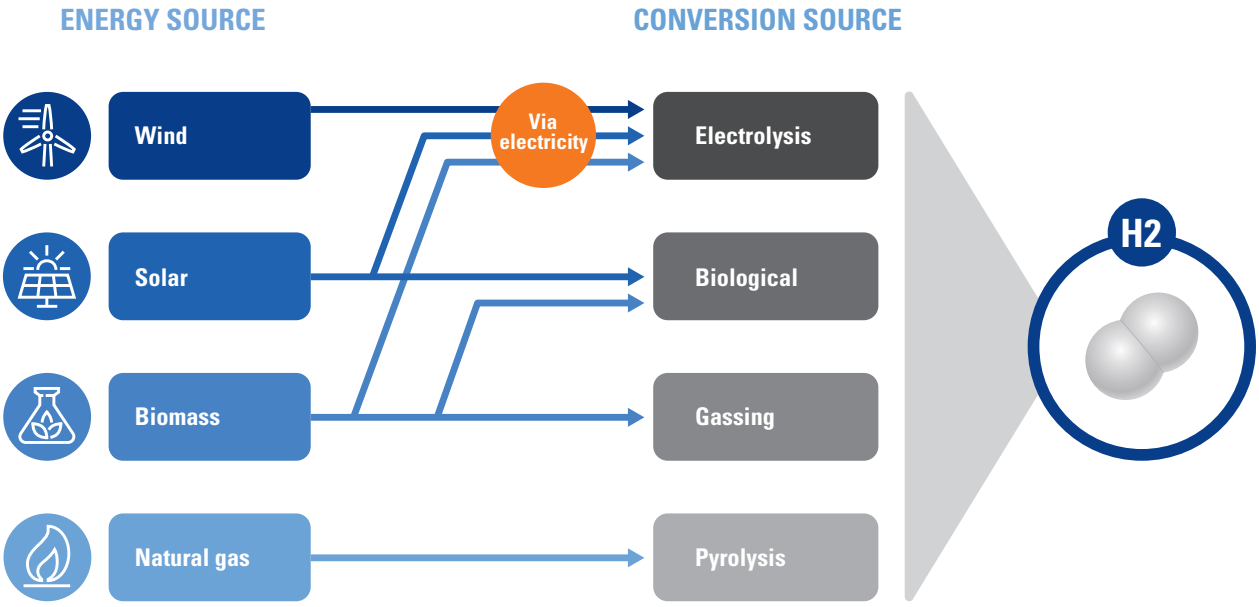
The perfect fuel for the future

HYDROGEN IN A NUTSHELL

Made up of only one proton and one electron, hydrogen is the simplest element in our universe. As it is found in all organic matter and in the water that covers 70% of the earth's surface, it is also the most abundant. And as the most efficient and the cleanest burning fuel acurrently available, hydrogen is also the perfect fuel for the future…

WHAT MAKES HYDROGEN UNIQUE?

Hydrogen can be produced and used in many (energy-)efficient ways, using various energy sources:



Currently, the reforming of natural gas by applying heat is the most economical process for producing hydrogen. A more and more popular alternative is electrolysis; producing hydrogen by using an electrical current to separate water into hydrogen and oxygen. When using electricity to produce hydrogen and vice versa, a renewable energy loop can be created, which is harmless to the environment.

HOW HAS HYDROGEN BEEN USED SO FAR?

Hydrogen has been used as a gas and liquid in a wide range of industries for many years, but also in more exotic applications, for instance as a fuel for the NASA space shuttle. Through the years, the range of hydrogen applications has grown significantly. Not only because of industrial progress, but also because of the obvious benefits it is offering, to both individual users and to the whole environment.

WHAT MAKES HYDROGEN THE PERFECT FUEL FOR VEHICLES AS WELL?

Hydrogen offers up to three times more energy than common fuels, and compared to these fuels, it produces NO harmful by-products upon combustion! Hydrogen can be used as a fuel to power vehicles in two ways:

- **In a fuel cell, to produce electricity,** which is the cleanest option.
- **In an internal combustion engine,** which still significantly reduces emissions (compared with common fuels).

WORKING SAFELY

With hydrogen

HANDLE WITH CARE

By itself, hydrogen is not explosive; only when it comes into contact with oxygen, chlorine or other oxidizers. Hydrogen burns with an almost invisible flame, and it is already flammable when mixed in small amounts with normal air. For this reason, hydrogen possesses the highest rating of 4 in terms of flammability by standards of the NFPA704 (the Standard System for the Identification of the Hazards of Materials for Emergency Response). Ignition can already occur at a volumetric ratio of hydrogen to air as low as 4%, due to the oxygen in the air and the simplicity and chemical properties of the reaction.

RISK-REDUCING REGULATIONS

Through years of hydrogen use in industrial applications, many safety regulations, guidelines, codes and standards have already been established. Today, the industry will always execute a risk management strategy as a de facto standard for any new application; for example, a commonly used hazard identification called HAZOP (Hazard and Operability study), followed by a risk assessment called LOPA (Layer Of Protection Analyses). These should always be followed by the design of risk-reducing measures called SIL (Safety Integrity Level). All these risk analyses for equipment and protective systems intended for use in potentially explosive atmospheres always have to comply with international safety directives, such as ATEX or IECEx. ATEX certification only applies to countries in the EU, while IECEx certification is more widely recognized and accepted compared to ATEX certification.

PUTTING SAFETY MEASURES INTO PRACTICE

The R. STAHL organisation not only has extensive knowledge of how to use and implement international safety directives, our team is also available for the guidance, execution and verification of projects that have to comply with EN-IEC 61511/61508 or EN-IEC 62061. This includes the calculation of SIL and its corresponding assessment for hydrogen applications. Using this extensive experience, we have been involved in setting up test facilities for car-vehicles hydrogen tanks as well as Full-Scale Stations (FSS) for hydrogen.

For both hydrogen application types, see the examples on the following pages.

HYDROGEN APPLICATIONS

By R. STAHL Electromach

TEST FACILITY FOR HYDROGEN TANKS IN VEHICLES

To ensure full safety when using hydrogen as a fuel for vehicles, the high-pressure hydrogen tanks need to be individually tested. To enable this, R. STAHL Electromach is involved in setting up test facilities, where extensive safety tests are performed.

During these tests, each tank is filled with hydrogen under full pressure (350 bar / 700 bar), after which each tank is unladed under controlled conditions and finally flushed to remove the last parts of hydrogen.

- **The scope of Electromach involves a PLC-based safety control system collecting all field input signals and controlling all valves and pumps for a safe (under controlled conditions) pressurizing and unloading of the vehicle hydrogen tanks.**
- **Design is based on discussed control narratives and process and instrumentation diagrams.**
- **To ensure a safe operation, intrinsically safe equipment and isolators are installed, and all applicable junction boxes are ATEX certified.**
- **Finally, the complete system needs to fulfill the safety rules. Execution of the SIL verification, and classification is done by our Functional Safety Engineers.**

FAIL-SAFE CONTROL SYSTEM

The control system for the tank test facility consists of a fail-safe PLC system, equipped with a panel PC as an operating device (HMI), digital and analog in- and outputs, and an Ethernet connection for communication purposes. All completed with the required explosion-proof switches, starters, distribution, relays and lights.


H2

HYDROGEN APPLICATIONS

By R. STAHL Electromach

FULL-SCALE STATION (FSS) FOR HYDROGEN

Following extensive testing, R. STAHL Electromach is also involved in the development and manufacturing of Full-Scale Stations (FSS) for hydrogen. Like any common fuel station, a Full-Scale Station is used for cars, trucks and buses, all running on hydrogen. However, as hydrogen refuelling is associated with extremely high pressures, it is critical that maximum safety is guaranteed at all times.

The FSS as developed by R. STAHL Electromach consists of a compressor container, which is connected to two individual storage containers and a dispenser to fill the cars, trucks or buses. These main components are containing the following vital parts:

- **Compressor container**
  Boosters – hydraulics – Unit Control Panel (UCP) – junction boxes – chiller – heat exchangers – valve racks
- **Storage container 1**
  Buffer storage for 350 bar vehicle filling – junction boxes – valve racks
- **Storage container 2**
  Buffer storage for 700 bar vehicle filling – junction boxes – valve racks
- **Dispenser**
  For filling of cars, trucks or buses

FOR THESE FULL-SCALE STATIONS, THE SCOPE OF R. STAHL ELECTROMACH INVOLVES:

- The Unit Control Panel (UCP) for the hydrogen Full-Scale Station (FSS) (based on fully documented design meetings with the customer)
- All required design documents: Control narratives, FSS controls design, P&ID FSS, HAZOP hydrogen Full-Scale Filling Station (FSS), Load list
- Intrinsically safe equipment
- Ex-certified junction boxes
- SIL verification and classification by our Functional Safety Engineers

FAIL-SAFE CONTROL SYSTEM

The control system for the hydrogen Full-Scale Station (FSS) consists of a fail-safe PLC system, equipped with a panel PC as an operating device (HMI), and digital and analog in- and outputs. An Ethernet switch for network connection is also available.

Furthermore, the system includes everything providing the required power and distribution: main switch, motor starters, soft starters, contactors, MCB's (both 24 V and 230 V), PSU, ESD provisions, interposing relays and Ex i isolators for all intrinsic signals from the field (both storage and compression containers).

R. STAHL ELECTROMACH

The solution provider

AREAS OF EXPERTISE

R. STAHL Electromach is an international leading design company with an extensive engineering and manufacturing expertise in explosion-proof control systems. Our components and systems can be applied in areas where gas and dust explosions may occur. Therefore, we are the obvious partner of choice for oil, gas, petrochemical and offshore applications such as in refineries and on oil rigs.

COMPETENCES AND SERVICES

All safety solutions by R. STAHL Electromach are customer-based and include the development of application software, manufacturing, assembly, testing and on-site commissioning. R. STAHL Electromach offers these solutions as full-service packages, from consultation and conceptual design to operation. We also take care of all international certification and providing after-sales support.

YOUR GLOBAL PARTNER

We are at your service around the globe: with 7 production sites, subsidiaries in 23 countries and more than 50 agencies.
Our international employees understand your needs and offer you R. STAHL Electromach quality – no matter where you need it.
Thanks to this global presence, we realise international joint projects that include customers, planners, installation companies and operators from various countries.

WHEN SAFETY IS YOUR CALL, CALL US FIRST

STAHL

ELECTROMACH B.V.
Jan Tinbergenstraat 193
7559 SP Hengelo, The Netherlands
T + 31 74 2 472 472
E electromach@r-stahl.com
electromach.com

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STAHL

ELECTROMACH B.V.
Jan Tinbergenstraat 193
7559 SP Hengelo, The Netherlands
T + 31 74 2 472 472
E electromach@r-stahl.com
electromach.com