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TESİSLERDE PROSES EMNİYETİ SEMPOZYUMU

3. ATEX SEMPOZYUMU

2-3 MAYIS 2024

TESİSLERDE PROSES EMNİYETİ SEMPOZYUMU

3. ATEX SEMPOZYUMU

Emerson Process Management

Hidrojenin Enerjideki Yeri ve Prosesteki Yönetimi

Ezgi Ulas
Account Sales Manager Oil&Gas – Sustainability
Turkiye & Azerbaijan

EMERSON

Hidrojen Nedir?

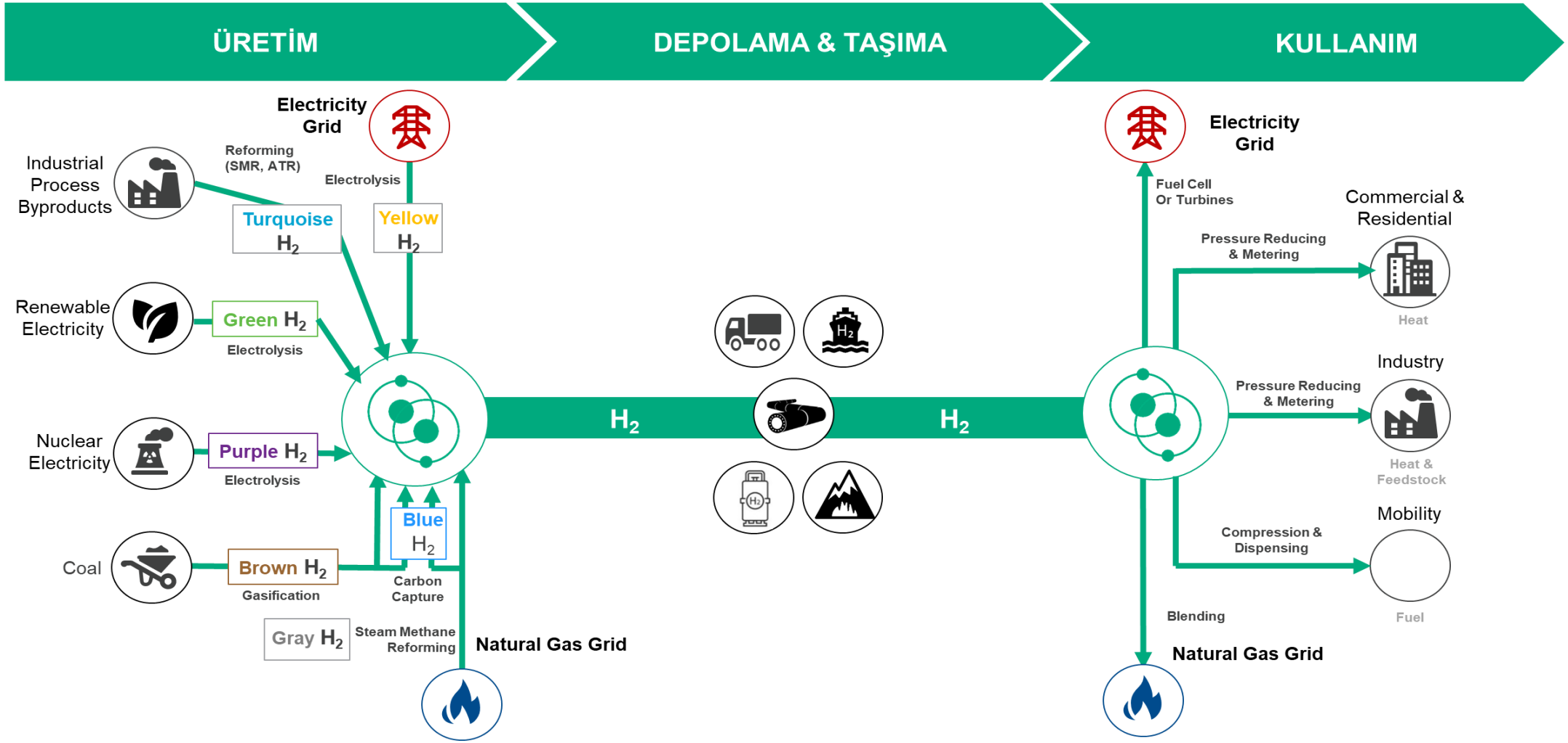
Hidrojen oksijenle yakılan ve yandığında sadece su buharı çıkan, sıfır karbonlu bir yakıt olduğundan fosil yakıtların yerini almaya aday olarak görülüyor.

Hidrojen evrende en bol bulunan kimyasal maddedir.

Hidrojen gazı, aralarında kovalent bağ bulunan iki hidrojen atomundan oluşur. Oldukça yanıcı, renksiz bir gazdır.

Hidrojen, diğer kimyasal reaksiyonlarda yapı taşı olduğundan üretilmesi caziptir. Bağ, kontrollü bir şekilde kolayca kırılır ve diğer kimyasallarla reaksiyona girerek günlük yaşamda kullanılan çok çeşitli kimyasalları oluşturur..

H2 Zinciri – Hidrojenin Üretim Renkleri



Olumlu Tarafı

Hidrojen CO2 ayak izini azalltarak gittikçe büyüyen enerji ihtiyacını karçılmamızda dünyamıza ve bize yardımcı olabilir

- Farkındalık; Emisyon oranı fazla olan sektörler bu değişime hazır
- Teknolojilerimiz hidrojeni güvenli bir şekilde üretmek, depolamak, taşımak ve kullanmak için uygun
- Yenilenebilir enerji kaynaklarından üretilerek depolanbilmesi arz /talep dengesinde gücümüzü besleyecektir

Zorlayıcı Tarafı

Hidrojen bugün ağırlıklı olarak Dogal gaz ve Kömür'den üretiliyor. Düşük karbon enrejisi bugün hala daha çok maliyetli

- Kitlesel bir hareket için yenilenebilir enerji ve H2 üretim maliyeti çok yüksek
- Üretimden son kullanıma kadar kurumlaması gereken döngü ve sektör kullanımı adaptosyonu hala başlangıç aşamasında
- Uygulama alanları için de ek bir maliyet öngörülmelidir

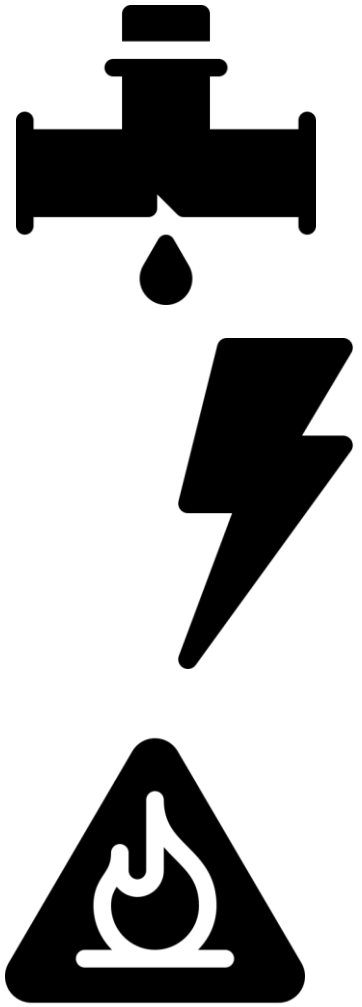
Hidrojenin Yapısı ve Özellikleri

Moleküler büyüklüğü nedeniyle en küçük boşluklardan bile sızmaya eğilimlidir.

Düşük kütlesi nedeniyle, her bir kg Hidrojen gazı ~1026 molekül içerirken, kömür ve metan gazının ~1025 molekülü vardır, dolayısıyla yaklaşık on kat daha fazla molekül içerir.

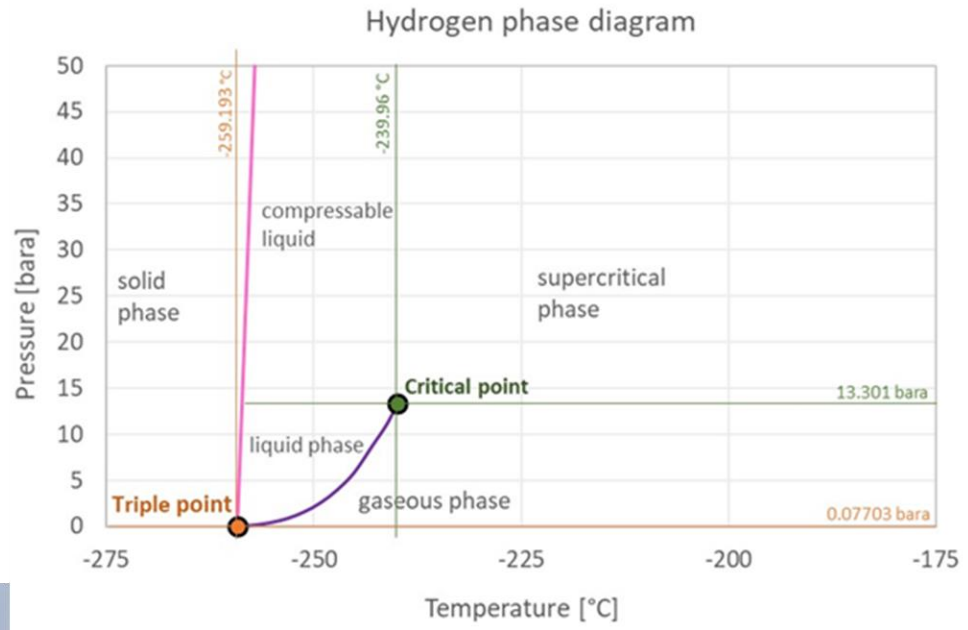
Sonuç olarak Hidrojen birim kütle başına diğer yakıtlardan daha fazla enerji içerir: ~45MJ/kg benzine kıyasla ~120MJ/kg, bu da onu oldukça reaktif bir yakıt kaynağı yapar.

Hidrojen gazı sızıntıya yatkın olmakla beraber, kokusuz, renksiz ve oldukça yanıcı olduğundan ve çok fazla enerji içerdiğinden standartlara ihtiyaç vardır!

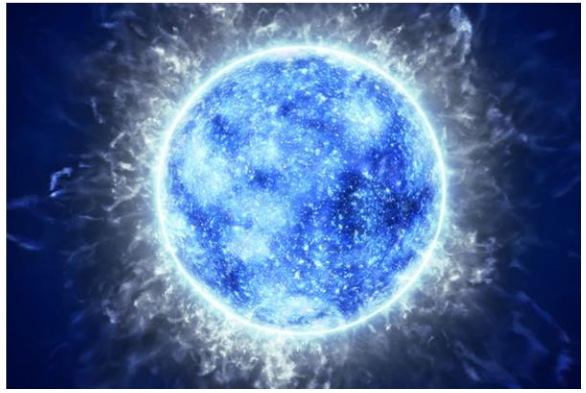


Hidrojen Akışının Ölçümündeki Proses Koşulları

LH2
Extremely Cool



H2 GAS
Extremely Light



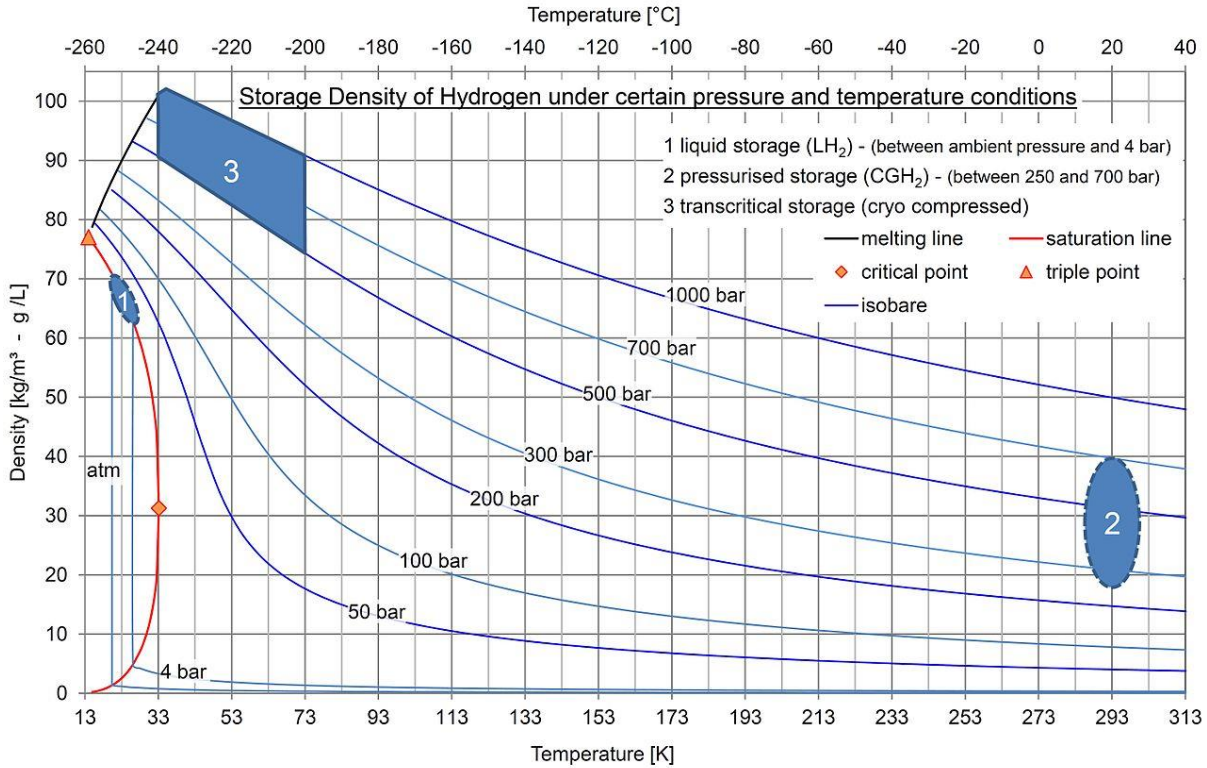
Hidrojeni Depolama ve Taşıma Yöntemleri

Depolama Yöntemleri

- Sıvı Depolama
- Basınçlandırarak Depolama
- Transkritik Depolama
- Katı Depolama

Proses Gereksinimleri

- Düşük Sıcaklık < -250 °C
- Yüksek Basınç > 250 bar
- Düşük Sıcaklık & Yüksek Basınç
- Adsorpsiyon



Source: ILK Dresden, Moritz Kuhn

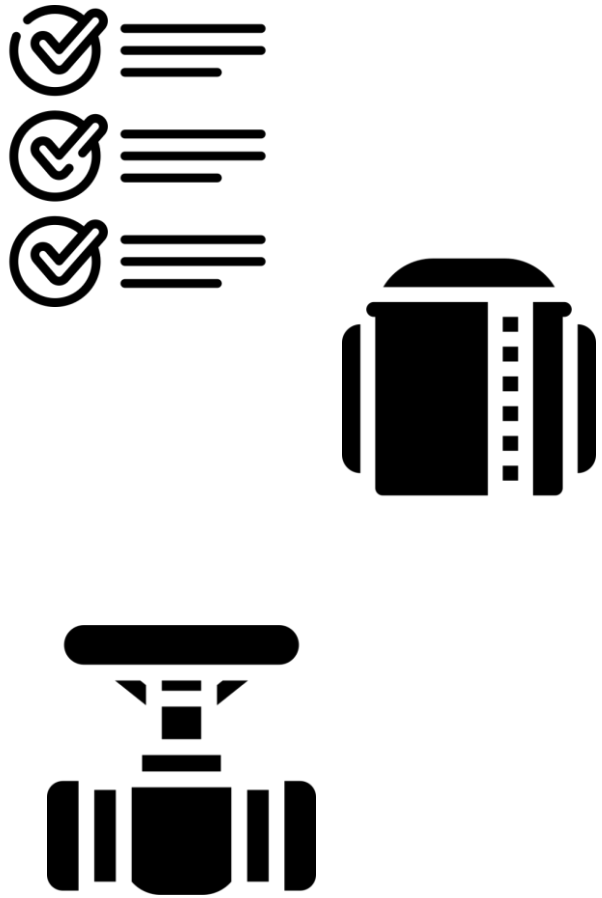
Hidrojen Standartları

Hidrojen Üretim & Depolama

- ASME B31.12 – Piping and Pipelines
- NFPA 2 – Generation, Storage & Handling
- NFPA 55 – Compressed Gases & Cryogenics
- ISO TC 197 – Production, Storage, Transport and Measurement

Hidrojen Yakıtı

- CSA ANSI HGV4 – Hydrogen Fuel Stations
- SAE J2579 – Fuel Cell



Malzeme Uyumluluğu ASME B31.12 – H2 Borulama Hatları

ASME B31.12-2019

Table A-2-1 Materials Compatible With Hydrogen Service

Material	Form of Hydrogen		Notes
	Gas	Liquid	
Aluminum and aluminum alloys	Acceptable	Acceptable	...
Austenitic stainless steels with greater than 7% nickel (e.g., 304, 304L, 308, 316, 321, 347)	Acceptable	Acceptable	Beware of martensitic conversion at low temperature if stressed above yield point
Carbon steels	Acceptable	Not acceptable	Too brittle for cryogenic service
Copper and copper alloys (e.g., brass, bronze, and copper–nickel)	Acceptable	Acceptable	...
Gray, ductile, or cast iron	Not acceptable	Not acceptable	Not permitted for hydrogen service
Low-alloy steels	Acceptable	Not acceptable	Too brittle for cryogenic service
Nickel and nickel alloys (e.g., Inconel and Monel)	Not acceptable	Acceptable	Beware of susceptibility to hydrogen embrittlement
Nickel steels (e.g., 2.25%, 3.5%, 5%, and 9% Ni)	Not acceptable	Not acceptable	Beware of ductility loss
Titanium and titanium alloys	Acceptable	Acceptable	...

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Malzeme Uyumluluğu ASME B31.12 – H2 Borulama Hatları

ASME B31.12-2019 - Hydrogen Service Maintenance

GR-5.11.1 Piping and Transportation Pipeline Valves

Valves that are required to be operated during an emergency shall be examined periodically and partially operated at least once a year to provide safe and proper operating conditions.

(a) Routine valve maintenance procedures shall include, but not be limited to, the following:

(1) servicing in accordance with written procedures by adequately trained personnel

(2) accurate system maps for use during routine or emergency conditions

(3) valve security to prevent service interruptions, tampering, etc., as required

(4) employee training programs to familiarize personnel with the correct valve maintenance procedures

(b) Emergency valve maintenance procedures include

(1) written contingency plans to be followed during any type of emergency

(2) training personnel to anticipate all potential hazards

(3) furnishing tools and equipment as required, including auxiliary breathing equipment, to meet anticipated emergency valve servicing and/or maintenance requirements

GR-5.11.2 Distribution System Valves

Valves, the use of which may be necessary for the safe operation of a hydrogen distribution system, shall be checked and serviced, including lubrication where necessary, at sufficiently frequent intervals to assure their satisfactory operation. Examination shall include checking of alignment to permit use of a key or wrench and clearing from the valve box or vault any debris that would interfere with or delay the operation of the valve. Valves in hydrogen service shall be checked and serviced at least annually.

GR-5.11.3 Service Line Valves

Outside shutoff valves installed in service lines supplying places of public assembly, such as theaters, houses of worship, schools, and hospitals, shall be examined and serviced, including lubrication where necessary, at sufficiently frequent intervals to assure their satisfactory operation. The examination shall determine if the valve is accessible, if the alignment is satisfactory, and if the valve box or vault, if used, contains debris that would interfere with or delay the operation of the valve. Unsatisfactory conditions encountered shall be corrected. Valves in hydrogen service shall be checked and serviced at least annually.

ASME B31.12 – Component Standards (valves)

Table IP-8.1.1-1 Component Standards

Standard or Specification	Designation
Bolting	
Square and Hex Bolts and Screws (Inch Series)	ASME B18.2.1
Square and Hex Nuts (Inch Series)	ASME B18.2.2
Metallic Fittings, Valves, and Flanges	
Pipe Flanges and Flanged Fittings: NPS ½ Through NPS 24 Metric/Inch Standard	ASME B16.5
Factory-Made Wrought Buttwelding Fittings	ASME B16.9
Face-to-Face and End-To-End Dimensions of Valves	ASME B16.10
Forged Fittings, Socket-Welding and Threaded	ASME B16.11
Ferrous Pipe Plugs, Bushings, and Locknuts With Pipe Threads	ASME B16.14
Valves — Flanged, Threaded, and Welding End	ASME B16.34
Orifice Flanges	ASME B16.36
Large Diameter Steel Flanges: NPS 26 Through NPS 60 Metric/Inch Standard	ASME B16.47
Wrought Copper and Copper Alloy Braze-Joint Pressure Fittings	ASME B16.50
Class 150 Corrosion Resistant Gate, Globe, Angle and Check Valves With Flanged and Butt Weld Ends	MSS SP-42
Wrought Stainless Steel Butt-Welding Fittings [Note (1)]	MSS SP-43
Class 150LW Corrosion Resistant Cast Flanges and Flanged Fittings	MSS SP-51
Socket-Welding Reducer Inserts	MSS SP-79
Bronze Gate, Globe, Angle and Check Valves	MSS SP-80
Class 3000 Steel Pipe Unions, Socket-Welding and Threaded	MSS SP-83
Integrally Reinforced Forged Branch Outlet Fittings — Socket Welding, Threaded, and Buttwelding Ends	MSS SP-97
Instrument Valves for Code Applications	MSS SP-105
Factory-Made Wrought Belled End Socket-Welding Fittings	MSS SP-119
Valves for Cryogenic Service Including Requirements for Body/Bonnet Extensions	MSS SP-134
Metallic Pipe and Tubes [Note (2)]	
Welded and Seamless Wrought Steel Pipe	ASME B36.10M
Stainless Steel Pipe	ASME B36.19M
Specification for Threading, Gaging and Thread Inspection of Casing, Tubing, and Line Pipe Threads	API 5B
Flanged Steel Pressure-Relief Valves	API 526
Check Valves: Flanged, Lug, Wafer and Butt-welding	API 594
Metal Plug Valves — Flanged, Threaded and Welding Ends	API 599
Bolted Bonnet Steel Gate Valves for Petroleum and Natural Gas Industries	API 600
Steel Gate, Globe and Check Valves for Sizes DN 100 and Smaller for the Petroleum and Natural Gas Industries	API 602
Corrosion-Resistant, Bolted Bonnet Gate Valves — Flanged and Butt-Welding Ends	API 603
Metal Ball Valves — Flanged, Threaded and Butt-Welding Ends	API 608
Butterfly Valves: Double Flanged, Lug- and Wafer-Type	API 609
Miscellaneous	
Unified Inch Screw Threads (UN and UNR Thread Form)	ASME B1.1
Pipe Threads, General Purpose (Inch)	ASME B1.20.1
Hose Coupling Screw Threads (Inch)	ASME B1.20.7
Metallic Gaskets for Pipe Flanges — Ring-Joint, Spiral Wound, and Jacketed	ASME B16.20
Nonmetallic Flat Gaskets for Pipe Flanges	ASME B16.21
Buttwelding Ends	ASME B16.25
Steel Line Blanks	ASME B16.48
Surface Texture (Surface Roughness, Waviness, and Lay)	ASME B46.1

GENERAL NOTE: It is not practical to refer to a specific edition of each standard throughout the Code text. Instead, the approved edition references, along with the names and addresses of the sponsoring organizations, are shown in Mandatory Appendix II.

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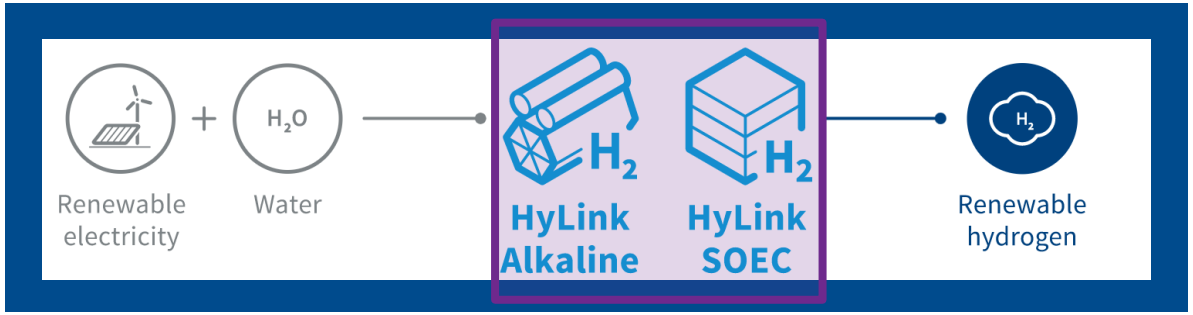
3. ATEX SEMPOZYUMU

Yeşil Hidrojen Üretimi Elektrolizör

Elektrolizör Tipleri

- **4 Tip Elektrolizör Bulunuyor**
  - Alkaline
  - PEM- **Polymer Electrolyte Membrane**
  - AEM- **Anion Exchange Membrane**
  - Solid Oxide (SOEC)- Reverse capabilities

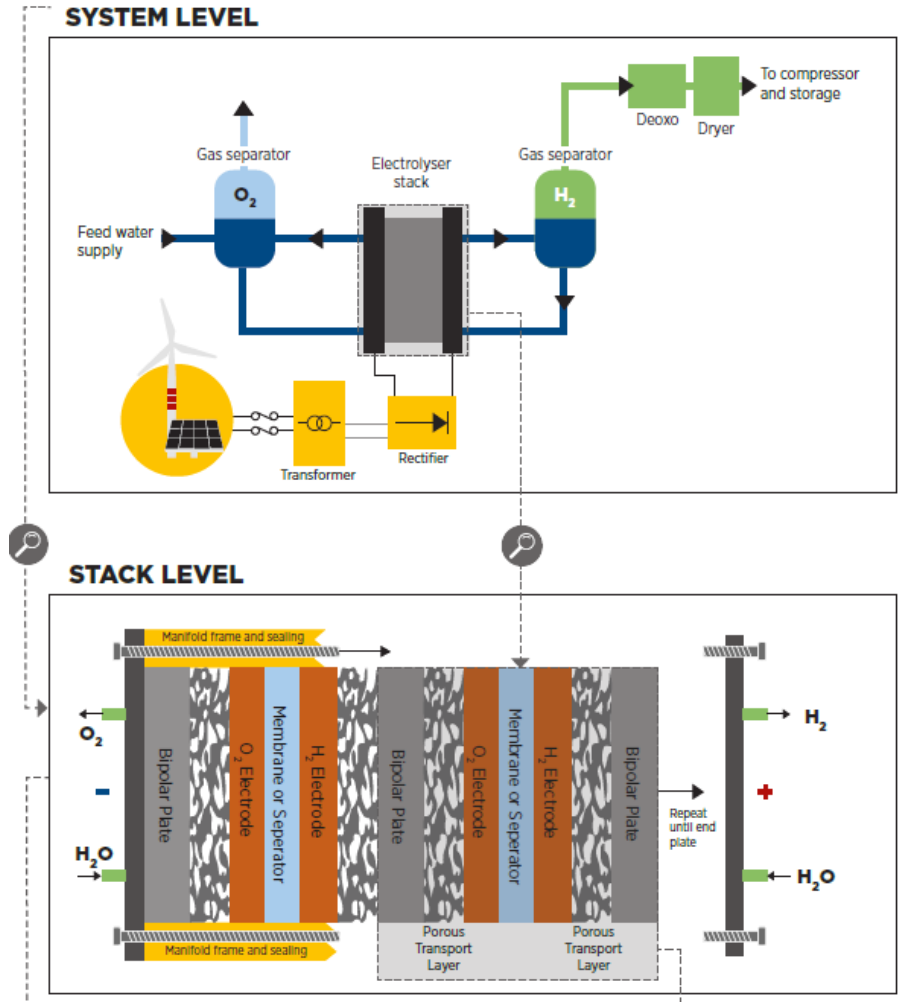


sunfire

ITM POWER

Our electrolysers are powered by renewable energy and use **our market leading PEM technology** which creates the purest green hydrogen in the market

Basic components of water electrolyzers at system and stack levels



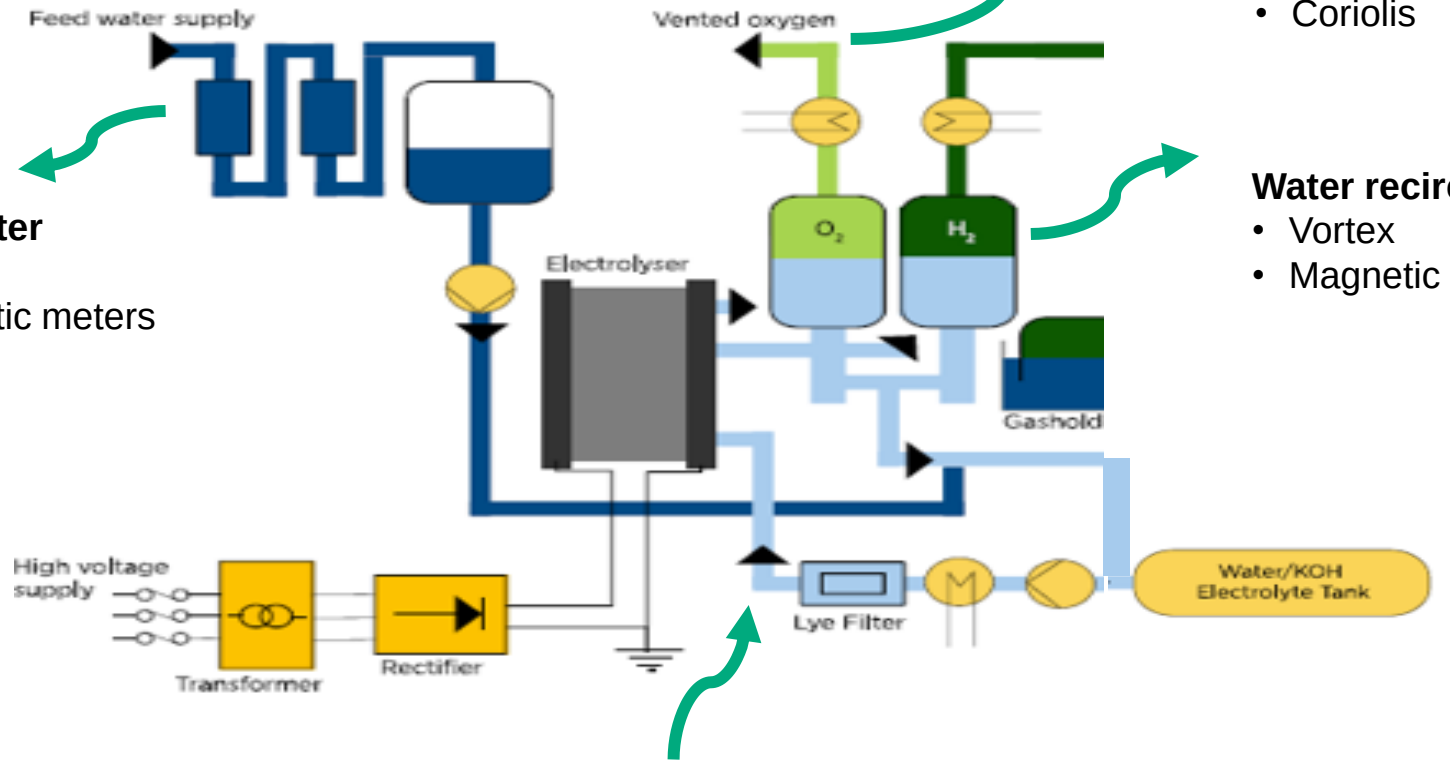
Alkalin - Advantajları and Dezavantajları

Avantajlar:

- Uzun süreli bilinen bir teknoloji
- Uzun süreli kararlılık
- Yüksek Verimlilik
- Düşük maliyet

Dezavantajlar:

- Korozyon Riski
- Yüksek Enerji Tüketimi
- Yüksek Bakım İhtiyacı



Feed Water Supply:
- Magnetic meters
- Vortex

Hydrogen Output:
- Vortex (not custody transfer)
- Coriolis

Water recirculation
- Vortex
- Magnetic meters

Water Lye:
- Magnetic meters

PEM - Advantajları and Dezavantajları

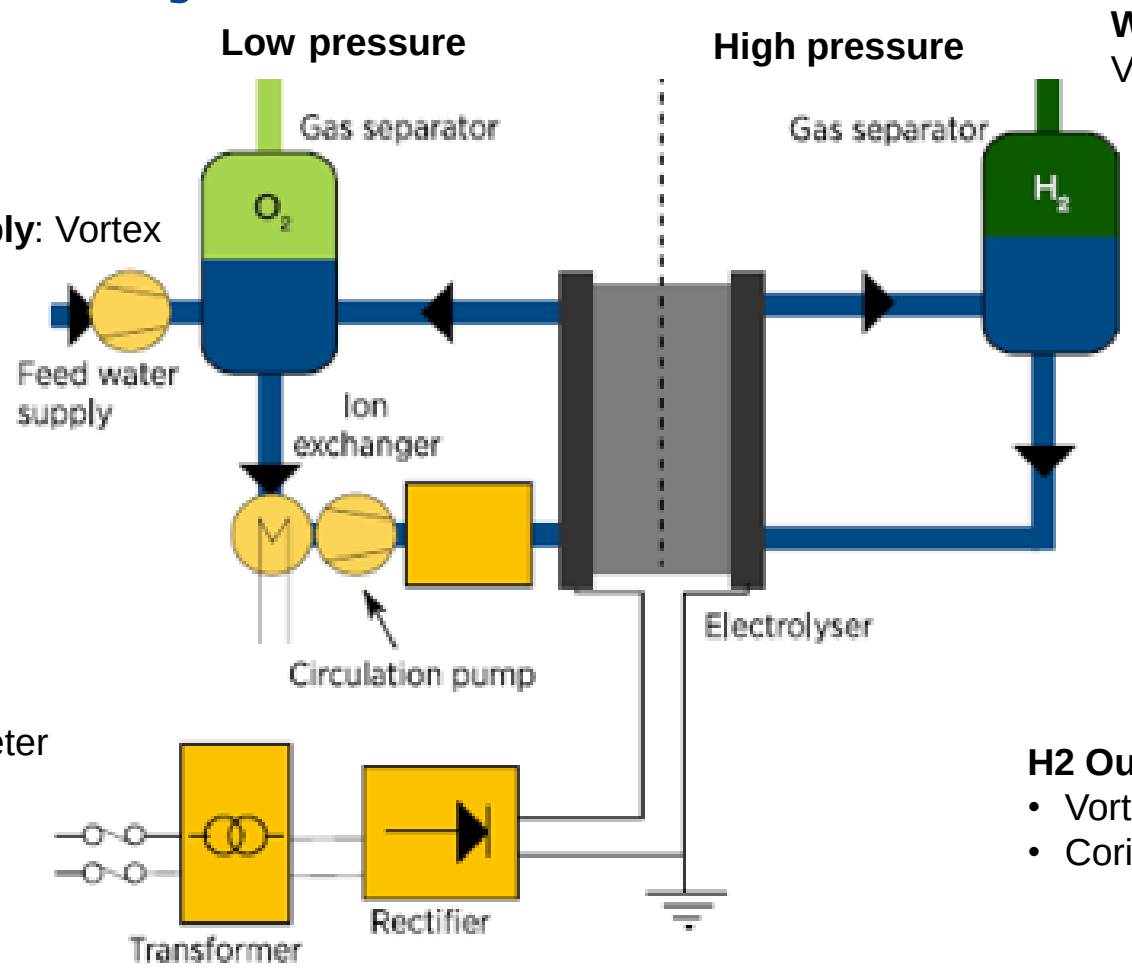
Advantajları:

- Hızlı adaptasyon
- Düşük bakım ihtiyacı
- Dinamik operasyon
- Kompakt sistem dizaynı
- Yüksek saflıkta hidrojen üretimi

Dezavantajları:

- Yüksek maliyet
- Dayanıklılık sorunları
- Yüksek bakım ihtiyacı
- Kullanım ömrü

Feed Water Supply: Vortex Flowmeter



O2 Output: Vortex Flowmeter

H2 Output:
- Vortex
- Coriolis

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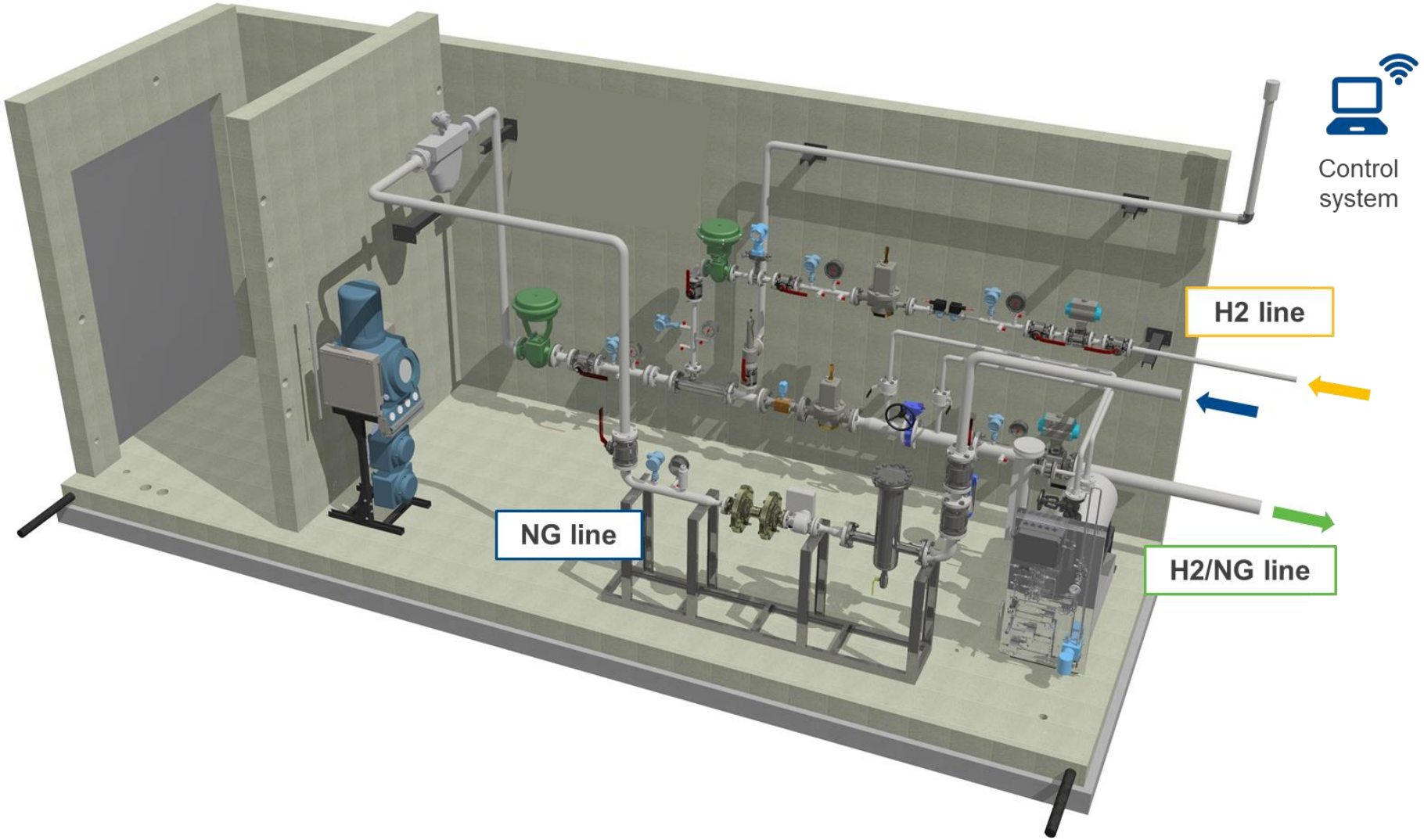
Hidrojen Dogalgaz Harmanlaması

Hidrojen ve Dogalgaz Harmanlaması

	Hydrogen	Natural Gas
Density	0.0696 sg	0.60 sg
Gas Group Classification	B	D
Heating Value	12.7 MJ per scm	39.8 MJ per scm
Toxicity	Non-toxic but an asphyxiant	Non-toxic but an asphyxiant
Molecular Weight	2.02	16.04
Wobbe Index Ratio	91.6%	100%
Volumetric Leak Ratio*	282-380%	100%
LEL (Lower Explosion Limit)	4% with air	5% with air
UEL (Upper Explosion Limit)	75% with air	15% with air
Joule Thompson Effect	Varies but warms up during pressure drop at room temp	5.6° C cooling / MPa
Odorization	Odorless/Colorless Some studies show standard odorants can work up to 100% H_2 but studies are on going	Odorless/Colorless Odorants are widely used

Hidrojen ve Dogalgaz Harmanlaması



- Pressure Control
- Gas Analysis
- Gas Measurement
- Odorant Injection
- Overpressure protection
- Control Systems
- Valves & Instrumentation

Hidrojen ve Doğalgaz Harmanlaması Sertifikasyonu

7070 Winchester Circle
Boulder, CO
80301 U.S.A.
(303) 527 5200
(800) 522 6277

Date: October 20, 2021

MANUFACTURER DECLARATION

for Micro Motion Coriolis Meters

Hydrogen Gas Measurement

Micro Motion certifies that all ELITE CMF and F-Series Micro Motion Coriolis meters manufactured by Emerson are suitable for measuring the mass and/or standard volume flow of hydrogen gas in either pure form or as mixed with natural gas or other gases in any proportions up to 100% pure hydrogen.

This declaration from the manufacturer is made available, as prescribed in the Physikalisch-Technische Bundesanstalt (PTB) TR G 19 *Technical Guidelines for Measuring Instruments for Gas*, to indicate that the ELITE CMF and F-Series Micro Motion Coriolis gas meters may be employed in applications governed by PTB regulations as follows:

- Meters are explicitly permitted by the manufacturer to measure mixtures of natural gas and hydrogen with hydrogen in concentrations greater than 5% mole fraction.
- Meters are permitted to measure mixtures of natural gas and hydrogen with hydrogen in concentrations greater than 10% mole fraction. When one is required for concentrations greater than 10% hydrogen, this declaration is to also be accompanied by a safety certificate issued by PTB.

Yours truly,

David J. Calvert

David J. Calvert
Director, Global Quality Management Systems
303-530-8567

April 9, 2021

Emerson Pressure Management, Automation Solutions
3200 Emerson Way
McKinney, TX 75070, USA (PRM Global Headquarters)

Subject: Emerson Regulator Products' Compatibility Statement for Natural Gas/Hydrogen Blending in Natural Gas Transmission and Distribution Infrastructures

Reference:

1. MARCOGAZ document 01-10-2019 - TF_H2-427 *"OVERVIEW OF AVAILABLE TEST RESULTS AND REGULATORY LIMITS FOR HYDROGEN ADMISSION INTO EXISTING NATURAL GAS INFRASTRUCTURE AND END USE"* and
2. **CEN/TC 234 [WI 00234088] "CEN/ TC 234/TR** - Gas infrastructure — Consequences of hydrogen in the gas infrastructure and identification of related standardization need in the scope of CEN/TC 234" (last revision on 17th August 2020)

Sustainability and Decarbonization have become an integral part of discussions around energy security and securing long term sustainable economic growth. With the aim of net zero emissions by 2050, many countries have introduced legislation and subsidies, along with public and private investment to encourage the use of renewable energy in place of traditional fossil fuels. For natural gas utilities, the injection of Hydrogen in their distribution network is accelerating the transition to a carbon neutral energy supply.

Even before recent discussions and regulations, Emerson pressure regulating products have been tried and tested in a variety of hydrogen applications for the last 60+ years. We are committed to supporting our customers' needs during this energy transition, ensuring the safe and reliable operations of their assets and continued progression of their most critical infrastructure upgrading projects.

With reference to the subject, we state that in the current design and based on available knowledge and Emerson's vast experience with hydrogen, (see above references), Emerson legacy products for gas infrastructures listed below are suitable for **Hydrogen/Natural gas blends up to 10% (volume) and total pressure up to 16 bar**. The product's inlet and pressure ratings have not changed, and they should not be used above those ratings.

A/143 Series	B/243 Series
BM/115	BM5X
Cronos	CSB400/CSB600/CSB700
EZH/EZHSO	EZHOSX
FL	FL-BP
M series (MN, MF, MBN, MBF)	OSE
HGR Series	

This statement is based on current technical information and knowledge, collected until today: possible extension of the products' suitability to total pressure range and/or blending rate to higher volumes shall be evaluated after results of further tests and investigations still in progress.

A full review of equipment and materials in natural gas infrastructure is still in-progress at Global and European Technical Committees level; key technical issues to be addressed concerning regulator products in Hydrogen/NG blended applications are:

- Requirements for external leakage rates and breather/vent openings (ref.: explosion risk assessment)
- Requirements for internal leakage (ref.: functional performances)
- Legacy material suitability (metallic and non-metallic) including permeation of gaskets, diaphragms, and o-rings

Consideration should also be given to pressure (total and partial pressure), temperature, and Hydrogen/NG blends composition in the referenced application. All Emerson pressure regulators are tested for bubble tight shut off meeting ANSI/FCI 70-3 Class VIII before leaving the factory.

Certificate/Declaration of Suitability and updated product data-sheets will be issued as soon as official standard and/or reliable reference will be available for equipment to be used with Hydrogen/NG blends in gas infrastructure.

In addition to our industry leading natural gas portfolio, Emerson also provides a full line of industrial regulators and other equipment which have been used in industrial hydrogen and NACE applications. These regulators are designed to be used up to **100%** hydrogen, meeting NACE MR0175-2002 and to the currently published pressure ratings in our technical literature.

MR95/98	67CF/67CFS
627	1098-EGR
1301	315A
T205	Y692/Y693

Technical Support

Our technical support team (Business Development Managers, Regional Managers, Application Engineers, Product Managers, and Product Engineering) is committed to supporting customers through this transition. Beyond our years of hydrogen industry experience, we have invested in expert engineering talent, upgraded our lab facilities with state-of-the-art test equipment, and developed 3D printing capabilities to support rapid prototyping, all to be able to provide customers with accurate, timely, and thoroughly tested recommendations.

Resources

In addition, we want to remind you of some resources readily available to address frequently asked maintenance questions and product training. Please visit the links below for more information.

Application Guide – Solutions for Natural Gas (download)
Product maintenance videos are available on the Regulators YouTube Page
Product Brochures, Instruction Manuals, Data Sheets and Product Bulletins Online

Best Regards,

Dan Haigh
VP, Engineering & Quality
Emerson, Pressure Management

Jim Griffin, PhD.
Dir., Research & Development
Emerson, Pressure Management

Ali Babaie, PhD.
Metallurgist
Emerson, Pressure Management

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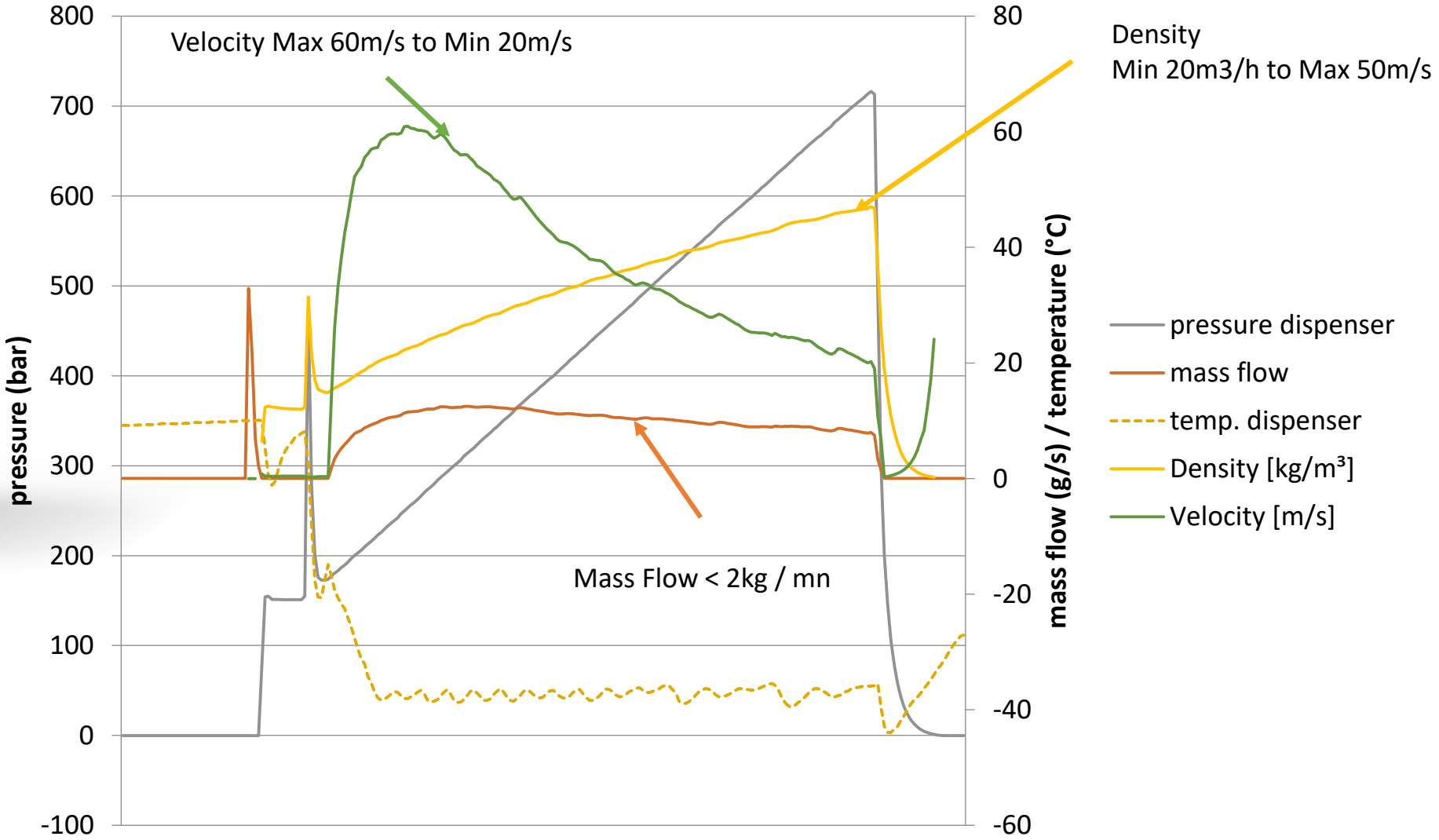
Hidrojen Dispenser

Hidrojen Dispenser

OIML & MID Certified
Water Calibration
Transferability



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SEMPOZYUMU

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TEŞEKKÜR EDERİZ.