



sphero[®]
HIGH SAFETY HYDROGEN STORAGE

walter tosto
INNOVATION AND DELIVERY



Walter Tosto uses **geometric perfection** to revolutionize the storage market with **Sphero**, an innovative spherical tank for **high-pressure hydrogen gas storage**.

In addition to the **shape**, the **materials** and **safety systems** bring Sphero to a perfect approach:

higher performance
more resistance
enhanced safety
lifetime extension

to make the processes of large industrial plants and hard-to-abate sectors **protected, sustainable** and ready for profitable use in a **circular economy**.

A **continuous monitoring system** addresses the problem of **unexpected structural ruptures**. However, the primary objective achieved by Walter Tosto's R&D department is to **ensure the storage time according to the desired life cycles**, further optimizing the efficiency and reliability of Sphero as a response to industry demands.

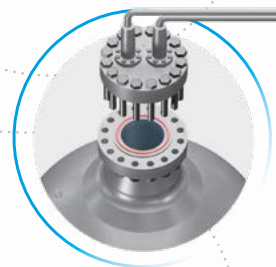
ideal structure

Without geometric discontinuities, the **spherical surface is ideal** to store the molecules of **hydrogen gas at high pressure**, the smallest in nature and in constant movement.

Inside Sphero, **uniformity at all points** can **delay** significantly the **level of hydrogen permeation** through the tank.

Sphero's structure includes:

- a single location of **nozzle** for the hydrogen inlet and outlet through the **manway**
- a **lower base** that includes anchoring, burial and possible immersion to keep the temperature of the tank constant



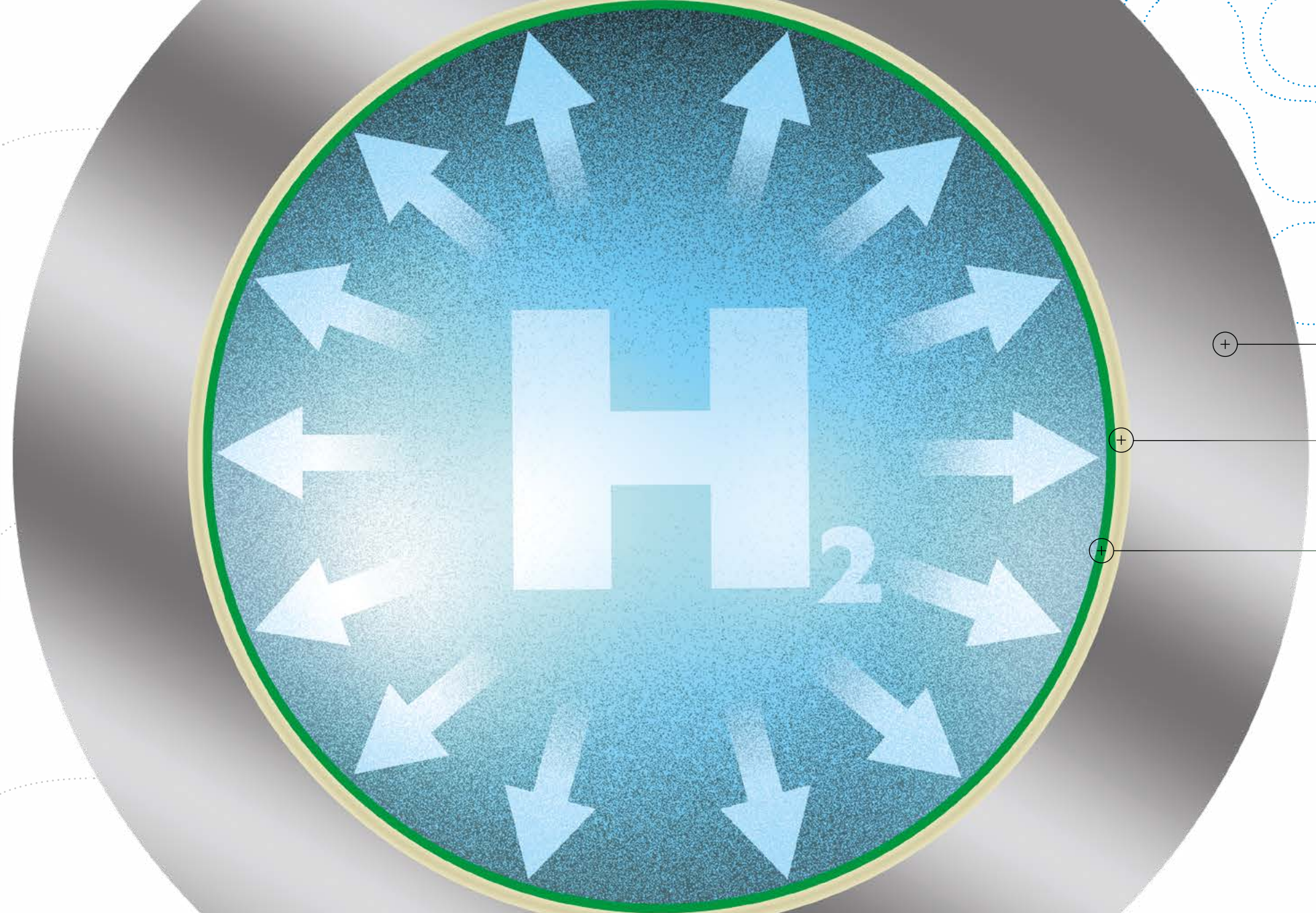
ANCHORING



BURIAL



IMMERSION



advanced materials

The in-depth research on **materials and treatments** carried out by Walter Tosto brings **solutions never seen before** in the gaseous hydrogen storage sector. Sphero is in fact characterized by **multiple technologies that increase the level of safety** exponentially.

An **external shell in high-strength steel**, further modified through **advanced homogenization treatments**, secure higher resistance, in combination with the **light weight** due to the lower thickness of the outer shell.

A **lining in 5000 series aluminium**, placed inside the sphere by using a specific technology patented by Walter Tosto, has a **very low permeability to hydrogen gas**, to deal with the typical deterioration phenomena of steel.

To provide an additional level of safety, a **polymer coating** can also be applied on the aluminium lining, thanks to the equipment specifically designed and fabricated by Walter Tosto. This patented technology adds a **third level of protection** that further reduces hydrogen permeability.

Considering the possible interaction between the steel and aluminium Walter Tosto proposes a solution by placing a **treated mesh** in the space between the lining and base material.



HIGH-STRENGTH STEEL



5000 SERIES ALUMINIUM



POLYMER COATING

high safety

Sphero decisively addresses one of the main problems related to high-pressure hydrogen storage: **possible structural failures without warning.**

The **high safety standard**, therefore, is one of the main advantages of Sphero, confirmed by shape and materials to **significantly delay the risk of hydrogen embrittlement and fatigue of the steel:**

- the spherical shape **reduces stress on the steel**, maintaining uniformity at all points
- homogenized high-strength steel, 5000 series aluminium and polymer layer **increase resistance to hydrogen embrittlement**

permeability to hydrogen = $\frac{\text{mol}}{\text{m} \cdot \text{s} \cdot \sqrt{\text{Pa}}}$

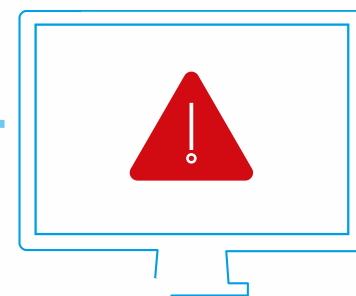
● STEEL 10^{-8}

● ALUMINIUM 10^{-18}

● POLYMER 10^{-13}

continuous detection

A further increase in the safety level is obtained through the introduction of a **detection system** between the steel and aluminium layer: a sensor **monitors continuously** any pressure differences related to the presence of hydrogen, providing an early warning to intervene promptly.

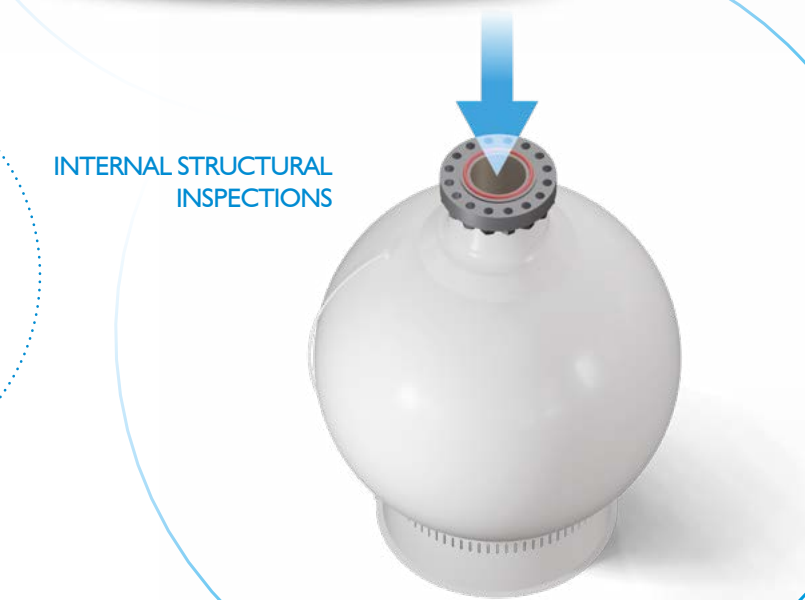
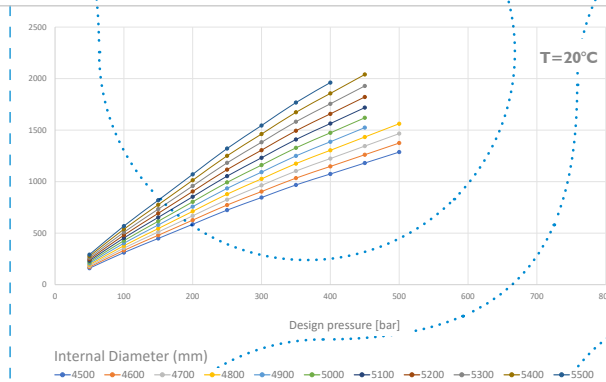
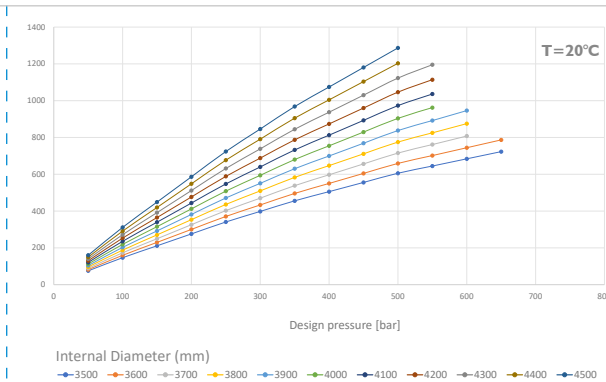
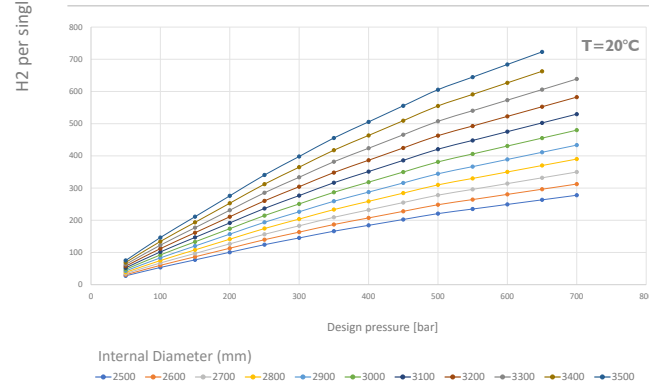
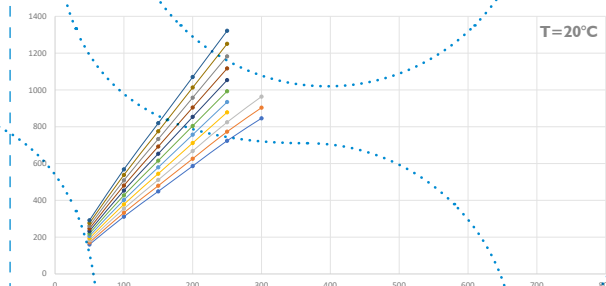
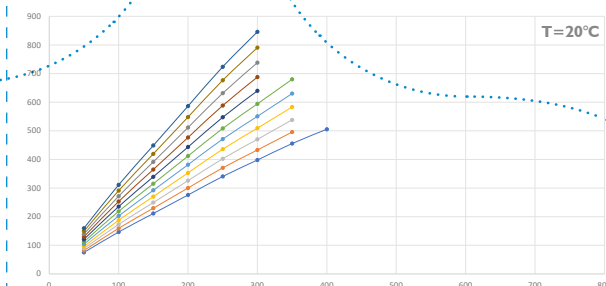
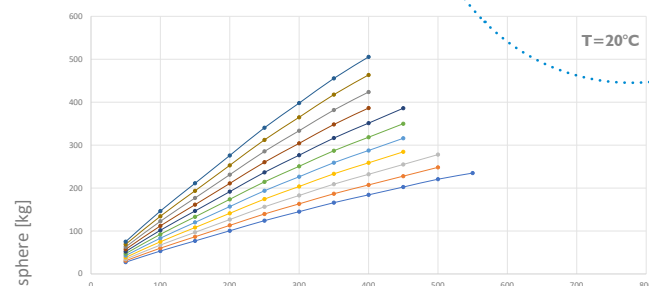


hydrogen storage capacity

SMALL SPHERES (2500 UP TO 3500 MM)

MEDIUM SPHERES (3500 UP TO 4500 MM)

LARGE SPHERES (4500 UP TO 5500 MM)



STEEL PLATE

FORGED STEEL

ensured duration

The innovative objective that guided the intense analysis and design phase of Sphero is to **ensure the storage time related to the desired life cycles.** Applying the **design code of the ASME** (American Society of Mechanical Engineers) Section VIII, Division 3, **accurate procedural calculations** were performed, both on the storage tank and in relation to the **fatigue cycles of the tank**, to guarantee maximum duration of a service.

Unlike conventional pack installations, Sphero allows a **maximum level of external inspection.** Furthermore, in case of a warning sent by the detection system, the manway entrance allows to perform further **internal structural inspections.**

The combination of all these features proposes an **innovative opportunity to repair** any possible defects before unexpected structural ruptures, thus **extending the average life of the tank.**

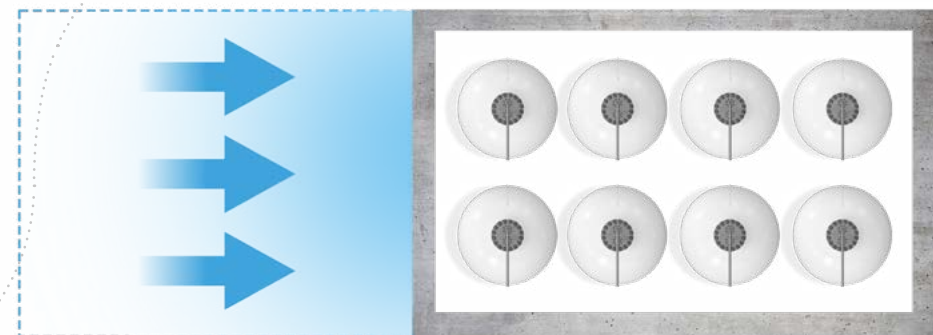
The nontraditional geometry of the manway is obtained by **contour forging process** which allows the inlet metal fibres to be aligned with the main structure of Sphero. A **clamp connection** which is alternative to traditional flange connections suits well for frequent and/or high **cyclic operation** that meets the current industry codes and standards for **hydrogen service.**

multiple benefits

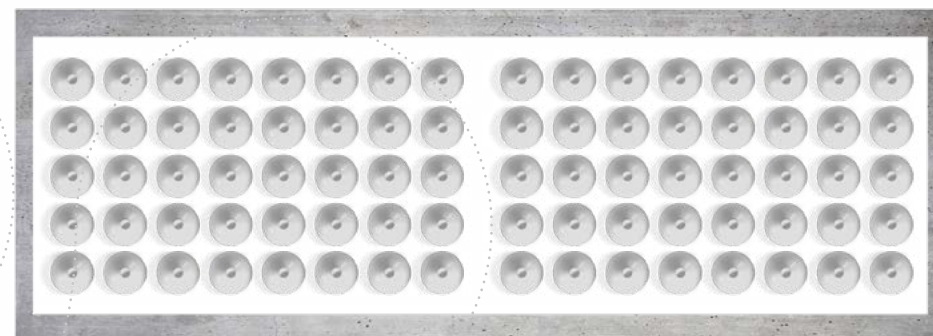
Sphero, for the same amount of hydrogen stored, **halves the footprint** and **reduces the number of units** in comparison to conventional storage.

The **economic advantages** are, therefore evident, thanks to the **reduction in civil works** conducive to the safety of the plant.

Further savings are related to the **minor required infrastructure** due to a lower quantity of units.



SPHERO
STORAGE 8x1



TRADITIONAL
STORAGE 80x1

sphero[®]
HIGH SAFETY HYDROGEN STORAGE

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A DIVISION OF

