Gpi | Tanks XL



How to reduce costs when purchasing a new storage tank?

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Duplex: the future for storage tanks

Sustainable business - & economical advantages of Duplex

Duplex stainless steels provide high strength and corrosion resistance that enable terminal & storage owners to benefit from durable storage tanks with a low lifetime cost.

Industrial operators have always been keen to minimize costs and invest in assets that provide value for money. The importance of the tank storage sector for our economy is great and will only increase in the future. Climate change demands the storage of new alternative energy carriers. Therefore, when investing in new storage tanks, it is wise to specify construction materials that not only represent the lowest lifecycle costs, but are also suitable for the storage of these new alternative energy carriers.

Duplex/Stainless steel not only offers advantages in terms of material cost, welding, assembly and fabrication, delivery and logistics, application of internal and external surface treatment and repair and maintenance, as well as the scrap value of the tanks at the end of its life.

Over a lifetime, the initial purchase price of the raw material is only a part of the total lifecycle cost. A growing number of tank and terminal owners are finding that choosing duplex / stainless steel provides the lowest lifetime costs.

Do you need advice or have questions? Contact us for a non-binding introductory meeting, we are happy to help you gain insight into our buildingmethods. For more information, please visit www.gpi-tanksxl.com.

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What is Duplex?

Duplex refers to a combination of austenitic and ferritic stainless steel. This means that 50–55% of the structure is ferritic and 45–50% is austenitic. As such, duplex stainless steel has two phases, combining the best properties of the austenitic "classics" and the ferritic chromium steel grades.

The first duplex grades were developed in 1930 by Avesta Ironworks in Sweden, which later became Outokumpu. The mill started selling the first two duplex grades to customers who needed to reduce intergranular corrosion, which can affect ferritic stainless steel. In the following decades, however, duplex stainless steel eked out a niche existence. It was not until the 1970s that metallurgists succeeded in developing more commercially successful duplex grades. In the 1980s, the spectrum was expanded, now ranging from low-alloy, lean duplex steels to:

Standard duplex stainless steel

The most common duplex stainless steel is the alloy EN 1.4462, which is characterised by its high chromium content (21–23% Cr) and a molybdenum content of 2.5–3.5%. Both elements give the steel excellent corrosion resistance. At the same time, the low nickel content ensures that the EN 1.4462 grade is comparatively stable in price. Large fluctuations in the nickel price have repeatedly caused volatile stainless steel prices in recent years. Common duplex accounts for about half of the duplex stainless steel available on the market.

Super duplex

The super duplex grades are the highest quality duplex stainless steels. They are characterised by a high content of alloying elements: 25% chromium, 7% nickel and 5% molybdenum. This gives these grades high corrosion resistance and mechanical strength, making them particularly suitable for critical applications in demanding environments, particularly in the oil and gas industry.

Hyper duplex

Some stainless steel producers have continued to extend highly alloyed grades (up to 33% of chromium) by developing hyper duplex grades with pitting resistance equivalent (PRE) of almost 50 (For comparison: A PRE of 35 is prescribed for applications in seawater). There are only a few large-scale applications that call for this extremely high corrosion resistance level, so hyper duplex grades have not yet reached the mass market.

Lean duplex

Lean duplex is the term for low-alloyed duplex stainless steels. Lean duplex stainless steels often replace austenitic stainless steel grades when there is a high risk of stress corrosion, for example. This brings us to tank and vessel construction—lean duplex has proven the ideal material for tanks in various industries. It contains a high proportion of manganese and nitrogen to compensate for its low nickel content. It provides high strength and good corrosion performance while remaining fully weldable. Grade EN 1.4162 (LDX 2101) is one of the most popular materials. If the tanks are used to store ethanol, biodiesel or palm oil, for example, lean duplex stainless steel is the first choice for Gpi.


VEERE

Mechanical advantages at a glance

High strength:

Duplex stainless steels are characterised by a high yield strength and work-hardening, while being stretchable. Due to these material's properties, tanks can be designed with very thin walls, saving material and weight and, in return, lowering the costs.

High strength means: less material, save labor, transport and erection

Duplex stainless steel has high strength compared with other types of stainless steel. This is particularly useful because it allows a thinner design.

This has three major benefits:

1. Less raw material needed to build the tank
2. More straightforward welding – the thinner the shell, the less time needs to be dedicated to welding the tank and less welding filler is needed.
3. Lighter weight also means less handling and therefore more speed in logistics on and around the construction site.

Good machinability:

Due to the good mechanical properties, lean duplex grades can be cold-formed without any problems. When it comes to hot-forming it is important to control the temperature range. Otherwise the balance between the austenite and ferrite phase is lost. Taking this into account forming is no problem.

Good general corrosion resistance:

Lean duplex corrosion resistance meets the tank and vessel construction requirements, alleviating the need for coating. The combination of high strength and corrosion resistance makes them a perfect match for applications in the chemical industry.

Good stress corrosion resistance:

Duplex stainless steels show a high resistance to stress corrosion cracking in chloride environments. They can replace austenitics for instance in chemical tanks and vessels.

Good craftsmanship

Duplex can often be more difficult to work and welding is more complex – at temperatures in excess of 250°C, the structure begins to change, which in turn impairs corrosion resistance and introduces brittleness. To prevent this from happening, it is important to work with this material in the correct manner. Gpi Tanks XL is specialised in working with Stainless Steel as well as Duplex.

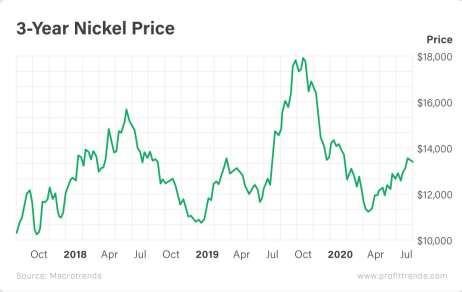
Economical advantages

Price:

Compared with austenitic stainless steel, duplex grades contain more chromium and nitrogen but less molybdenum and nickel for a corresponding corrosion resistance. And because nickel and molybdenum prices have been known to fluctuate widely, duplex grades offer the important benefit of price.

Nickel prices fluctuate

Due to the low nickel content, lean duplex stainless steels are price-stable. The price of nickel, for example, rose from 15,000 to 50,000 US dollars per tonne in 2008 - and then fell again. This caused great turbulence among manufacturers, users and stockholders. Since then, market participants have been preferring price-stable options.



In tank construction, material can be saved significantly through the use of Lean Duplex. Less material consumption also means lower costs. In many enduser industries, price plays a decisive role. To remain competitive, the production price must be as low as possible. Lean duplex helps reaching this goal.

Life cycle costs:

Due to low maintenance costs, the use of lean duplex quickly pays for itself. While components made of coated carbon steel require maintenance or refurbishment during its lifetime, lean duplex parts maintain their quality. Carbon steels may be cheaper to purchase, but in the long run there is no way around Lean Duplex in terms of price.

Sustainability:

Policymakers are increasingly pushing for sustainable products and processes. This is reflected in the corresponding standards, rules and regulations. Sustainable material like Lean Duplex, which can be recycled virtually over and over again, helps companies achieving their sustainability goals.

CUSTOMER CASES

Do the previous explanations hold up in practice? Allow us to demonstrate with a few customer cases. In all three cases, lean duplex plays a major role. These are just three examples for the use of duplex stainless steel in tank construction. In all three cases, lean duplex material EN 1.4162 (LDX 2101) was used to the complete satisfaction of our customers. We are happy to present further examples on request.



7317m³ Tank
22.750 mm Ø



1558 m³ Tank
12.500 mm Ø

503m³ Tank
8.000 mm Ø



1016 m3 Tank
9.700 mm Ø



First case:
USG Geleen

Gpi constructed an on-site tank for USG Geleen, the Netherlands, with a capacity of no less than 7300 m3. USG Industrial Utilities handles the purchasing, production, distribution and sales of electricity, steam, technical gases, nitrogen, air and water for companies on the Chemelot industrial complex. The project comprises a flat-bottomed tank with a sump. The sump alone has a volume of over 8000 litres. The tank also has a conical roof built to the EN 14015 standard, which has a vertex of 158 degrees, a diameter of nearly 23 metres, is strong enough to walk on and takes the overall height to over 20 metres. That results in a gross volume of approximately 7600 m3 and a net volume of around 7300 m3.

Both 304 stainless steel and LDX2101 duplex steel were used for the tank. The lower part of the body is made of LDX2101, which is stronger than SS304 and allows a thinner structure while retaining the structural strength. The tank floor, top and upper part of the body are made of SS304.



First case:

Volume 7.317m³

TANKDESIGN	
Diameter	22.750 mm Ø
Cylindrical height	18.000 mm
Design temperature	50 °C
Design pressure	-10 / 25 mbar(g)
Product densitiy	1.000 kg/m³
Snow load	700 N/m²
Live load	1.000 N/m²

MATERIALS COMPARISON			
Material	**Carbon Steel S235JR / S355JR ***	**Stainless Steel 1.4301 (SS304)**	**Duplex 1.4162 (LDX 2101)**
Thickness bottom plate	8 mm	6 mm	5 mm
Anular ring thickness	10 mm	8 mm	6 mm
Thickness shell course 1	15 mm	13 mm	8 mm
Thickness shell course 2	14 mm	12 mm	8 mm
Thickness shell course 3	13 mm	11 mm	8 mm
Thickness shell course 4	12 mm	10 mm	6 mm
Thickness shell course 5	11 mm	9 mm	6 mm
Thickness shell course 6	9 mm	8 mm	5 mm
Thickness shell course 7	8 mm	8 mm	5 mm
Thickness shell course 8	6 mm	6 mm	5 mm
Thickness shell course 9	6 mm	5 mm	5 mm
Thickness shell course 10	6 mm	5 mm	5 mm
Thickness shell course 11	6 mm	5 mm	5 mm
(top) Thickness shell course 12	6 mm	5 mm	5 mm
Number of wind girders	2 pcs	2 pcs	3 pcs
Roofplate thickness	5 mm	4 mm	4 mm
Number of roof rafters	36 pcs	38 pcs	36 pcs
Dimension roof rafters	IPE240	U 150 x 170 x 150 - 6 mm	U 120 x 150 x 120 - 4 mm
Conservation - protection inside and outside tank conservation (paint treatment incl. materials and scaffolding	€€€	none	none
Total cost of ownership (TCO) periodic inspections of corrosion & the periodic sand-blasting and recoating of the tanks.	€€€	none	none
Weight tank	170.000 kg	127.000 kg	**93.000 kg**



Second case

Steam project

Gpi Tanks engineered and manufactured four stainless steel tanks for a major steam project. With this project, our customer invested in an innovative technology to convert water-based waste into energy. The steam technology is an extension to their plant where chemicals are produced for clothing, furniture, household products and construction materials. The new installation will transform the production's waste into steam, which will be used as an energy source in the existing production plant.

Gpi delivered four tanks for this innovative project: a 70-tonne, 1553-m^3 aerobic biofeed surge tank, a 55-tonne, 1108-m^3 anaerobic biofeed surge tank, a 23-tonne, 500-m^3 Arcru storage tank and a 4-tonne, 48-m^3 urea storage tank. The tanks were all built from duplex stainless steel (LDX 2101) and designed and produced according to NEN-EN 14015 and PGS29 standards. The specified pressure of + 500 mbarg was a major challenge, both in design and production, resulting in substantial material thicknesses and extra heavy anchoring of the tanks.



Second case

Volume 503m³

TANKDESIGN 1	
Diameter	8.000 mm Ø
Cylindrical height	10.000 mm
Design temperature	160 °C
Design pressure	-6 / 140 mbar(g)
Product densitiy	970 kg/m³
Snow load	700 N/m²
Live load	1.000 N/m²

MATERIALS COMPARISON			
Material	**Carbon Steel P265GH**	**Stainless Steel 1.4301 (SS304)**	**Duplex 1.4162 (LDX 2101)**
Thickness bottom plate	6 mm	5 mm	4 mm
Anular ring thickness	-	-	-
Thickness shell course 1	8 mm	4 mm	3 mm
Thickness shell course 2	6 mm	4 mm	3 mm
Thickness shell course 3	5 mm	3 mm	3 mm
Thickness shell course 4	5 mm	3 mm	3 mm
Thickness shell course 5	5 mm	3 mm	3 mm
Thickness shell course 6	5 mm	3 mm	3 mm
(top) Thickness shell course 7	5 mm	3 mm	3 mm
Number of wind girders	-	1 pc	1 pc
Roofplate thickness	5 mm	4 mm	4 mm
Number of roof rafters	14 pcs	14 pcs	14 pcs
Dimension roof rafters	IPE100	U 70 x 100 x 70 - 3 mm	U 45 x 75 x 45 - 3 mm
Conservation - protection inside and outside tank conservation (paint treatment incl. materials and scaffolding	€€€	none	none
Total cost of ownership (TCO) periodic inspections of corrosion & the periodic sand-blasting and recoating of the tanks.	€€€	none	none
Weight tank	18.000 kg	12.000 kg	**10.000 kg**



Second case

Volume 1558m^3

TANKDESIGN 2	
Diameter	12.500 mm Ø
Cylindrical height	12.700 mm
Design temperature	120 °C
Design pressure	-5 / 500 mbar(g)
Product densitiy	1.000 kg/m^3
Snow load	700 N/m^2
Live load	1.000 N/m^2

MATERIALS COMPARISON			
Material	**Carbon Steel P265GH**	**Stainless Steel 1.4301 (SS304)**	**Duplex 1.4162 (LDX 2101)**
Thickness bottom plate	6 mm	5 mm	4 mm
Anular ring thickness	8 mm	6 mm	6 mm
Thickness shell course 1	12 mm	9 mm	5 mm
Thickness shell course 2	11 mm	9 mm	4 mm
Thickness shell course 3	10 mm	8 mm	4 mm
Thickness shell course 4	10 mm	8 mm	4 mm
Thickness shell course 5	8 mm	6 mm	4 mm
Thickness shell course 6	6 mm	6 mm	4 mm
Thickness shell course 7	5 mm	5 mm	4 mm
Thickness shell course 8	5 mm	4 mm	4 mm
(top) Thickness shell course 9	5 mm	4 mm	4 mm
Number of wind girders	-	-	1 stuk
Roofplate thickness	5 mm	5 mm	4 mm
Number of roof rafters	20 pcs	20 pcs	20 pcs
Dimension roof rafters	IPE140	U 100 x 120 x 100 - 4 mm	U 75 x 100 x 75 - 3 mm
Conservation - protection inside and outside tank conservation (paint treatment incl. materials and scaffolding	€€€	none	none
Total cost of ownership (TCO) periodic inspections of corrosion & the periodic sand-blasting and recoating of the tanks.	€€€	none	none
Weight tank	60.000 kg	39.000 kg	**25.000 kg**



Third case

Calcium pigments, fillers and granules

Gpi Tanks designed and produced six stainless steel tanks for a client specialised in the production of high-quality calcium carbonate pigments, fillers and granules.

The tanks were constructed in 304L stainless steel and LDX2101 duplex steel. The lower part of the body is made of LDX2101, which has improved properties compared to stainless steel 304L and allows a thinner structure while retaining the structural strength. The tank floor, top and upper part of the body are made of 304L stainless steel.

> The popularity of duplex is only a matter of time. It is not yet as well known as the (austenitic) types 304(L) and 316(L) stainless steel, and many customers are only just discovering its use. Welding technology must be adapted, plate thicknesses and finishes must be estimated—not every tank manufacturer is ready for this, but we are.

SPECIAL ENGINEER
— WIKTOR CZEREP



Third case

Volume 1.016m³

TANKDESIGN	
Diameter	9.700 mm Ø
Cylindrical height	13.750 mm
Design temperature	90 °C
Design pressure	-6 / 35 mbar(g)
Product densitiy	1.980 kg/m³
Snow load	700 N/m²
Live load	1.000 N/m²

MATERIALS COMPARISON			
Material	**Carbon Steel S235JR**	**Stainless Steel 1.4301 (SS304)**	**Duplex 1.4162 (LDX 2101)**
Bottom plate thickness	6 mm	5 mm	4 mm
Anular ring thickness	-	-	-
(bottom) Thickness shell course 1	9 mm	10 mm	5 mm
Thickness shell course 2	8 mm	9 mm	5 mm
Thickness shell course 3	7 mm	8 mm	4 mm
Thickness shell course 4	6 mm	7 mm	4 mm
Thickness shell course 5	5 mm	6 mm	4 mm
Thickness shell course 6	5 mm	5 mm	4 mm
Thickness shell course 7	5 mm	4 mm	3 mm
Thickness shell course 8	5 mm	3 mm	3 mm
Thickness shell course 9	5 mm	3 mm	3 mm
(top) Thickness shell course 10	5 mm	3 mm	3 mm
Number of wind girders	1 pc	1 pc	1 pc
Roofplate thickness	5 mm	4 mm	4 mm
Number of roof rafters	16 pcs	16 pcs	16 pcs
Dimension roof rafters	IPE140	U 70 x 100 x 70 - 4 mm	U 50 x 90 x 50 - 3 mm
Conservation - protection inside and outside tank conservation (paint treatment incl. materials and scaffolding	€€€	none	none
Total cost of ownership (TCO) periodic inspections of corrosion & the periodic sand-blasting and recoating of the tanks.	€€€	none	none
Weight tank	28.500 kg	27.000 kg	**18.500 kg**



Conclusion

Duplex stainless steels, with special emphasis on lean duplex grades, are emerging as an ideal material for tank construction. Their exceptional combination of high corrosion resistance, robust mechanical strength and favourable machinability not only provides economic benefits, but also ensures optimal price-performance ratios. The use of duplex stainless steel contributes significantly to achieving sustainability goals for various companies. Consequently, duplex is the preferred choice for use in the construction of storage tanks in various industries, including but not limited to the chemical sector, food and beverage production and pulp and paper production.

By choosing duplex stainless steel, companies can leverage the inherent advantages of these materials to ensure long life and reliability of their storage tank infrastructure. Integrating lean duplex grades further improves the cost-effectiveness of such structures. Should you have any questions about the use of (lean) duplex in tank construction, our team of experienced engineers is ready to provide comprehensive help and guidance. Feel free to contact us for expert insights and tailor-made solutions for your specific tank construction needs.

Want to know more?
Get in touch

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