

Steels for gas containers

Durable steel designed for safety

ArcelorMittal's gas container grades guarantee the durability, strength and safety of your gas cylinders. They also enable you to create gas containers that are cost-effective and significantly lighter than traditional steel bottles.

ArcelorMittal's range of gas container grades have excellent deep drawability and are non-ageing. They include both hot rolled flat steels (P grades) and cold rolled, very high strength steels (Dual Phase steels).

ArcelorMittal was the first steelmaker to develop a light steel gas cylinder that is almost half the weight of a traditional steel gas bottle. Together with our clients we have demonstrated that this solution also brings significant cost savings.

ArcelorMittal received the Swedish Steel Prize for this breakthrough development.



Hot rolled steels offer durable advantages

ArcelorMittal's hot rolled steels (P grades) for gas containers are a specific category of steels that are suitable for creating pressure vessels. Our P grades offer the following advantages:

- Excellent deep drawability
- Very good weldability
- Outstanding toughness
- Non-ageing properties

The strength of the hot rolled steels remains constant, even after heat treatments such as normalising or stress-relief annealing. This property guarantees the safety of the gas containers.

ArcelorMittal's P grades can be used for the production of two- and three-piece welded gas containers that meet international standards including EN 1442, EN 13322, EN 14140 and EN 14638. The top and bottom are cold formed, welded (SAW, GMAW) and subsequently normalised or stress-relieved.

The lightweight solution

ArcelorMittal's high strength cold rolled grade for gas cylinders is DP600 AM FCE. The Dual Phase grade is a specialised steel which can be used to produce lightweight gas cylinders. Compared to conventional steel bottles, weight savings of more than 40% are possible.

During production, the steel undergoes a specific heat treatment in a continuous annealing line. This results in its Dual Phase structure.

DP600 AM FCE for gas cylinders provides:

- Excellent formability (low yield ratio Y_s/T_s)
- High strain-hardening (strength increase during forming)
- Good weldability
- Excellent fatigue properties

No post-heat treatment required

Dual Phase grade DP600 AM FCE is specifically designed for use in the production of two-piece, refillable gas containers which meet international standards EN 14140 and EN 14638. The top and bottom shells are deep drawn and welded (GMAW, MAG). The DP600 AM FCE is left in 'as welded' condition. No post-heat treatment is required, saving on production costs.

All the usual arc welding methods (MAG, GMAW, SAW) can be used for this application.

High strength and excellent drawability

Dual Phase steels offer an excellent combination of strength and drawability as a result of their good ductility and strain-hardening capacity.

For example, in DP600 AM FCE, yield strength increases by about 120 MPa after a 2% plastic strain in uniaxial tension (a phenomenon known as work-hardening). Yield strength can be increased further after paint curing using bake-hardening (BH₂).

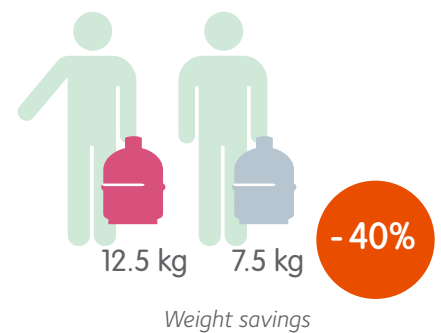
Steel: the ecological solution

ArcelorMittal's P grades and DP600 AM FCE are specifically designed for gas bottle applications. This saves you energy during production, lowers your CO₂ footprint, and the steel is 100% recyclable at the end of the product's life. Lighterweight products also result in energy savings during transport.



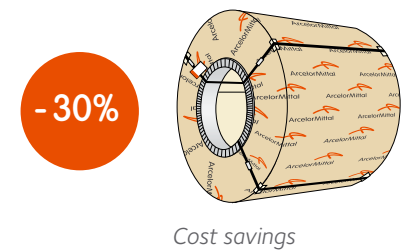
Dual Phase steel: 40% weight saving

Compared to conventional steel bottles, ArcelorMittal's Dual Phase steels offer weight savings of more than 40% on a standard steel bottle. Weight drops from 12.5 kg to just 7.5 kg, a 5 kg saving. This provides our clients with a very clear competitive advantage as steel gas bottles can be now slightly lighter than the composite ones.



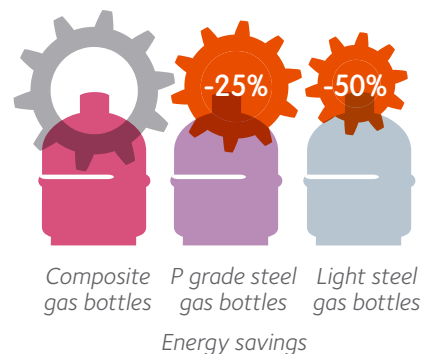
Including a cost saving of 30%

As the new Dual Phase steel gas bottle is lighter, less steel is needed. Material cost savings with ArcelorMittal's Dual Phase grades are substantial. Additionally to the value created by material cost savings, one process step at the customer (the normalisation treatment) is eliminated.



Energy savings

The energy required to produce the new steel gas bottles is 50% lower than that required to produce an equivalent composite bottle. Compared to a traditional steel solution, the saving is around 25%. The savings occur at all stages of the production process from materials and cylinder production to transport.



Brand correspondence

● Hot rolled	EN 10120:2008	JIS G3116:1991	Old brand names
P245NB EN 10120	P245NB	SG 255	BZ 37
P265NB EN 10120	P265NB	SG 295	BZ 42
P310NB EN 10120	P310NB	SG 325	
P355NB EN 10120	P355NB	SG 365	
● Cold rolled	PrEN 10338:2009	DIN SEW 097-2:2000	
DP600 AM FCE	HCT600X	H340X	

Quality control for safety

Gas cylinders in DP600 AM FCE meet all requirements and have passed all validation tests described in EN 14140. They are also TÜV certified.

Mechanical properties

● Hot rolled	Direction	Thickness (mm)	R _e (MPa)	R _m (MPa)	A ₈₀ (%)	A 5.65√S ₀ (%)	notes	
P245NB EN 10120	T	1.5 - 3	≥ 245	360 - 450	≥ 26	-	1	
		3 - 5			-	≥ 34		
P265NB EN 10120	T	1.5 - 3	≥ 265	410 - 500	≥ 24	-		
		3 - 5			-	≥ 32		
P310NB EN 10120	T	1.5 - 3	≥ 310	460 - 550	≥ 21	-		
		3 - 5			-	≥ 28		
P355NB EN 10120	T	1.7 - 3	≥ 355	510 - 620	≥ 19	-		
		3 - 5			-	≥ 24		
● Cold rolled	Direction	Thickness (mm)	R _e (MPa)	R _m (MPa)	A ₈₀ (%)	n 90		BH ₂ (MPa)
DP600 AM FCE	L	1 - 2	340 - 410	≥ 600	≥ 20	≥ 0.140		≥ 30

1 All mechanical properties are guaranteed in normalised or normalised rolled condition.

Chemical composition

● Hot rolled	C (%)	Mn (%)	P (%)	S (%)	Si (%)	Al (%)	Nb (%)	Ti (%)	N (%)
P245NB EN 10120	≤ 0.160	≥ 0.30	≤ 0.025	≤ 0.015	≤ 0.25	≥ 0.020	≤ 0.050	≤ 0.030	≤ 0.009
P265NB EN 10120	≤ 0.190	≥ 0.40	≤ 0.025	≤ 0.015	≤ 0.25	≥ 0.020	≤ 0.050	≤ 0.030	≤ 0.009
P310NB EN 10120	≤ 0.200	≥ 0.70	≤ 0.025	≤ 0.015	≤ 0.50	≥ 0.020	≤ 0.050	≤ 0.030	≤ 0.009
P355NB EN 10120	≤ 0.200	≥ 0.70	≤ 0.025	≤ 0.015	≤ 0.50	≥ 0.020	≤ 0.050	≤ 0.030	≤ 0.009
● Cold rolled	C (%)	Mn (%)	P (%)	notes					
DP600 AM FCE	≤ 0.140	≤ 2.10	≤ 0.040	1+2					

The chemical properties given are based on cast analysis data.

Values in bold: tighter than the standard

1 The sum of the percentages by mass of the two elements chromium and molybdenum shall not exceed 1%.

2 The sum of the percentages by mass of the two elements niobium and titanium shall not exceed 0.15%.





Case study: partnership development gives new lift to a proven product

ArcelorMittal was the first steelmaker to develop a lightweight gas bottle in close cooperation with our clients.

Today, a number of successful co-development projects have already been realised, and many more are ongoing.

The idea of developing a new, light steel gas bottle was suggested to ArcelorMittal's Industry R&D centre (Ghent, Belgium) by one of our existing clients.

In collaboration with the client, our technicians decided to begin with a clean-sheet design. That meant finding a type of steel that could easily be deep drawn and that would be suitable for submerged arc welding.

Using the ArcelorMittal product catalogue, the technicians selected a range of steel grades that met the design criteria. Finite element simulations were conducted to investigate the properties of each steel further. This narrowed the selection to a few suitable steel grades.

In close collaboration with the customer's own technicians, the cold rolled Dual Phase 600 (DP600 AM FCE) steel was selected for its excellent deep drawing capabilities and work-hardening characteristics.

40% weight reduction

Once the steel was identified, the new light-weight gas cylinders were developed. The new models meet international standards and have passed all validation tests the customer has undertaken.

The weight of the gas bottles has been reduced by 40% by using DP600 AM FCE. While the cost of this grade is slightly higher than the steel the customer previously used, less material is required. This results in a significant cost saving for the same number of units.

By switching to Dual Phase steel, the customer has been able to simplify the manufacturing process which has led to additional cost reductions. ArcelorMittal's engineers and technicians provided professional and effective support through these vital changes.

The new gas cylinder now weighs 7.5 kg when empty. That's slightly less than the equivalent composite bottle. The new steel cylinder holds 10 kg of gas, which means that a full bottle weighs only 17.5 kg.

Co-development projects such as these demonstrate the clear benefits of working with a global partner such as ArcelorMittal.

We are here to help you

ArcelorMittal has dedicated support engineers and research experts ready to help with questions on welding, cutting and forming. We have years of experience in successful co-development with many satisfied customers.

For the latest technical data or further information, please regularly consult our online product catalogue at www.arcelormittal.com/fce. Or contact us at fce.technical.assistance@arcelormittal.com

Another typical application where these steels are used: an LPG tank of a car



Credits

Images: Tom D'Haenens, Jeroen Op de Beeck, with thanks to ArcelorMittal Global R&D Gent, Philippe Vandenameele, Fotosearch

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