

Carbone Lorraine

CL-CLAD[®]



CARBONE LORRAINE

Dedicated Innovation, Dedicated Partner

The new reliable cladding
technology
By Carbone Lorraine



What is CL-Clad

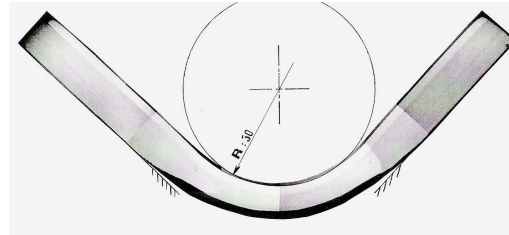
- CL-Clad[®] is a brazing process patented by CARBONE LORRAINE
- Base plate is made of carbon or stainless steel
- CL-Clad[®] bonding is resistant to full vacuum
- A thin layer (0.5 to 1mm) of Ta, Ti or Zr is added to the base plate
- Main application for this new material is pharmaceutical reactors
- Main material used for this application: Tantalum

CL-CLAD plate properties

CL-Clad

Explosion Clad

Bending test



Bending Radius	30 mm	30 mm
Bond fault (%)	<1	<1
Shear strength (MPa)	140	140
Thermal shock 220°C→20°C	Pass	Pass
Vacuum resistance at 220°C	Pass	Pass

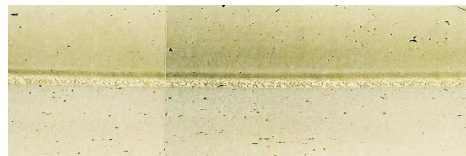
CL-CLAD samples



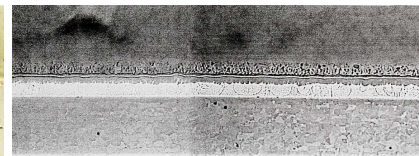
0.7 mm of reactive metal + 10 mm steel



Ta / Steel



Ti / Steel



Zr / Steel

Reactive metal
Braze alloy
Steel

Main advantages of CL Clad



CL CLAD technology used for the fabrication of CPI reactors improves 3 key parameters :



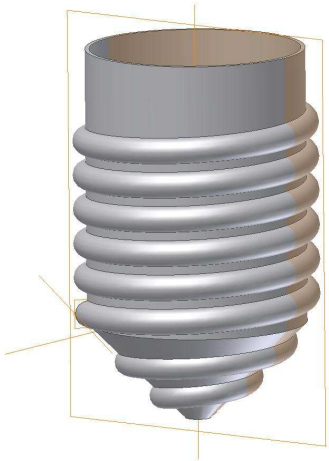
- **PRODUCTION CAPACITY**



- **MAINTENANCE COSTS**

- **SAFETY**

Production capacity improvement



- Better thermal conductivity:

Thermal conductivity of tantalum is greater than glass lining:

1kcal/m.h.°c for glass

47,6kcal/m².h.°C for tantalum

The heat transfer between the reactor and jacket is more efficient.

CL-CLAD®

→ *Be efficient*

Production capacity improvement



- Good resistance to thermal shock:

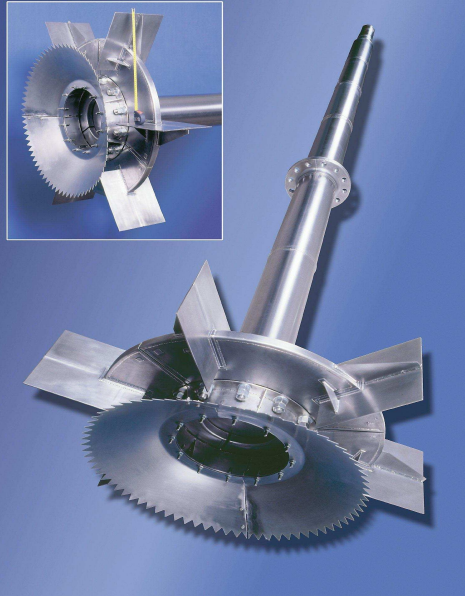
A CL-Clad reactor can be heated or cooled from 20°C to 200°C instantaneously without any damage.

→ Better flexibility and productivity of the reactor

→ Ideal for batch production.

CL-CLAD®
→ *Improve resistance*

Production capacity improvement



- Agitation improvement:
 - An agitation system can be optimised for each specific application
 - Our partner, who has specialised in agitation for many years can design a complete agitation system (agitator, baffles, motor)
 - Sharp shapes can be fabricated for better efficiency
- Baffles can be welded on reactor wall, which is more efficient than a beavertail baffle.
- Optimising the agitation system will improve the efficiency of the reactor. Thus reaction times and/or reactor volume can be reduced.

CL-CLAD®

→ *Optimise process*

Maintenance costs



- Life time improvement
- **Resistant to mechanical shocks:**
CL-Clad lining resists mechanical shocks which reduces maintenance requirements
- **Resistant to thermal shocks:**
CL-Clad resistant to rapid heating or cooling (ΔT : 200°C). Maintenance operations can therefore be performed quicker.
- **Resistant to corrosion:**
Reactive metals resistant to high temperature and very corrosive products.

CL-CLAD®

→ **Reduce costs**

Maintenance costs



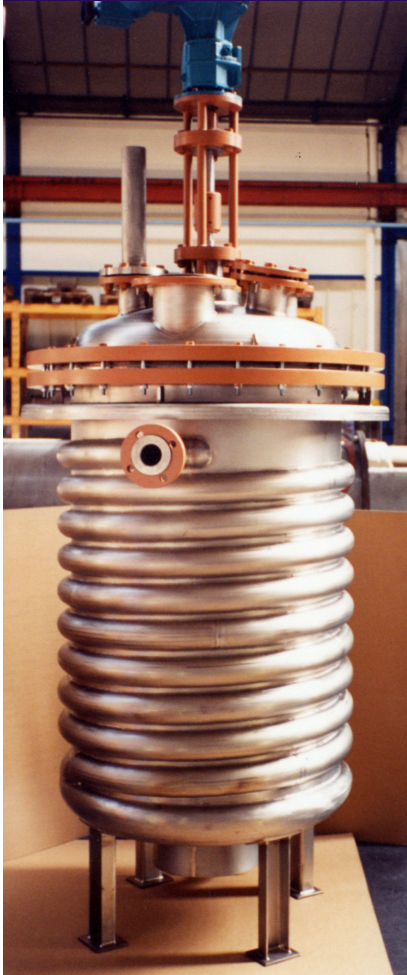
- Corrosion resistance from outside:

In a corrosive atmosphere, the carbon steel base can be damaged.

→ CL-Clad can be done on a stainless steel base

CL-CLAD®
→ *Resistant to corrosion*

Maintenance costs



- Optimisation of clean in place process
- Usual cleaning solvents can be used at the optimised temperature on CL-Clad
- Less precautions to be taken, thanks to good shock resistance

CL-CLAD®

Clean easily

Safety improvement

- **Resistant to electrostatic shocks:** As CL-Clad material is conductive, there is no risk of electrostatic shocks which can damage the lining. This satisfies the ATEX requirements.

- **Heavy metals free:** There are no heavy metal particles in the reactive metals lining, which can pollute the product.

- **Resistant to tightening:**
 - ✓ bolts instead of clamps: improved sealing
 - ✓ no risk of cracks with CL-CLAD®

A diagram consisting of an orange L-shaped line that starts vertically, then turns 90 degrees to the right to form a horizontal arrow pointing towards the text 'Secured product'.

CL-CLAD®
→ *Secured product*

Advantages of CL-Clad compared to explosion clad



- **Thiner reactive metal lining:**

Ex: Minimum Ta lining thickness with CL-Clad: 0.5mm

Minimum Ta lining thickness with Explosion Clad: 1mm

⇒ CL-Clad is less expensive

- **Thiner base plates:**

Ex: Minimum steel base plate thickness with CL-Clad: 3mm

Minimum steel base plate thickness with Explosion Clad:
10-15mm

⇒ CL-Clad is lighter

⇒ CL-Clad is easier to roll/bend especially for
small equipment

- CL-Clad has the same material cohesion and the same vacuum and flexion resistance as explosion clad

■ Glass-lined equipment

- **Very fragile, less resistant against thermal shock**
 - **Regular maintenance required**
 - **Potential safety concerns**
 - **Low heat-up and cool down \Rightarrow long process cycles**
 - **Requirement for many clamps to close the reactor and ensure the tightness**

- **Low thermal conductivity**
 - **Low Heat transfer**
 - **Less precise control of the reaction temperature**

Reactor range

Carbone Lorraine proposes a complete range of reactors produced with CL-Clad technology:

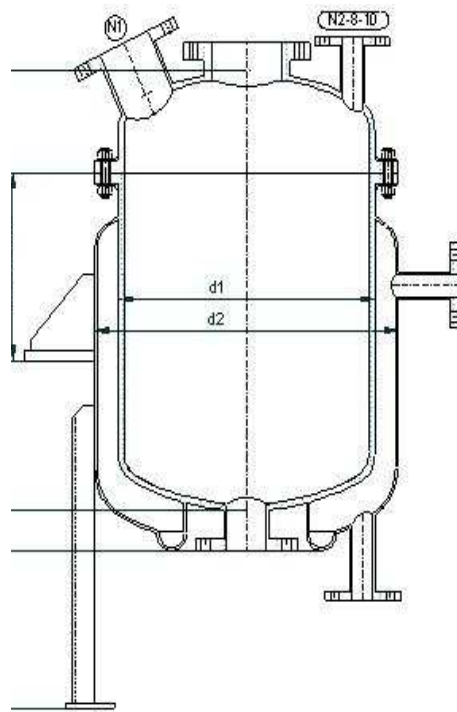
- Standard range according to DIN28136 dimensions
- Special reactor designs, against customer's specifications
- Reactors can be completely equipped (agitation, sight glasses...)



CL-CLAD®

Customer satisfaction

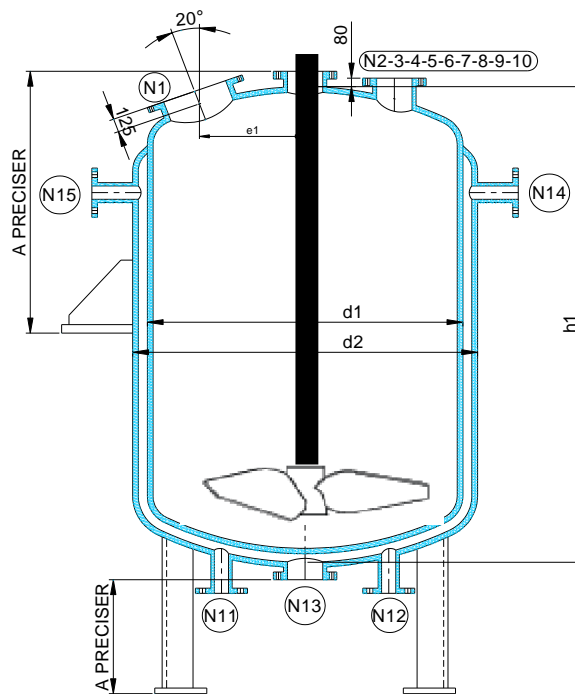
DIN 28136 range



Type A:

Double compartment vessel

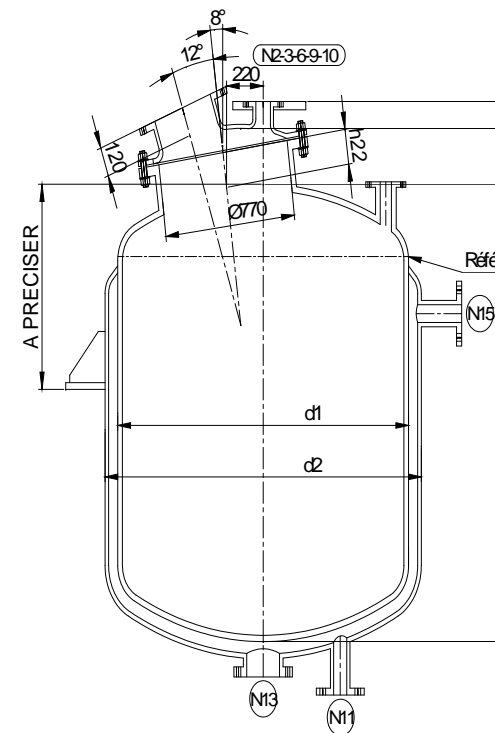
63L to 6300L



Type B:

Single compartment vessel

1600L to 40000L



Type C:

Single compartment vessel with mounted cover

1600L to 40000L

Other CL-Clad equipment

All reactors, vessels, columns, tanks can be produced with CL-Clad technology.



CL-CLAD®

The solution