

The [ladle shroud nozzle](#) for continuous casting is also called the protective sleeve. It is an important component connecting the ladle and the tundish. It is connected to the lower shroud of the sliding shroud device at the bottom of the ladle, and the lower end extends into the tundish.

The shroud is an important functional [refractory material](#) for maintaining casting and improving steel quality. The length of the shroud is generally 600-1800mm, the pipe diameter is 90-150 mm, and the structure of the ladle shroud nozzle is shown in Figure 2. Its use conditions are harsh and must have the following functions: excellent thermal shock resistance; good mechanical strength; excellent resistance to alternating corrosion of molten steel and slag, high oxidation resistance, and in addition, other suitable properties are required for some special steel grades. more information, please check [here](#)

[Tundish nozzle](#)

[Slide Gate Plate](#) is a critical component in the continuous casting process, used to [control the flow](#) of molten steel from the ladle or tundish to the crystallizer. The following is a detailed description:

## Role and Function

- **Flow Control:** The [sliding gate plate](#) adjusts the opening size of the nozzle through the sliding mechanism, thereby controlling the flow of molten steel. This is very important for maintaining a constant and controllable casting process.
- **Operational Flexibility:** The sliding gate plate allows operators to adjust the molten steel flow rate as needed during the casting process to adapt to different production requirements and conditions.
- **Emergency Stop:** In an emergency, the [sliding gate plate](#) can completely close the flow channel and stop the flow of molten steel, thereby preventing accidents and losses.

### Slide gate plate for Converter

The [slide gate plate](#) is made of sintered corundum, fused corundum, fused zirconium corundum, zirconium mullite and other main raw materials. It is combined with new resin, formed by high pressure and fired at high temperature. It has the advantages of high strength, super hard, high temperature resistance and corrosion resistance, and strong thermal stability.

[Stopper](#)

[Monoblock Stopper](#) is used mainly for flow control on Molten Steel poured from tundish to mould. [Monolithic Stopper](#) is installed in the Tundish above the **Sub Entry**

**Nozzle** and the gap between stopper head and Nozzle decide the throughput requirement of Molten Steel inside the Mould.

Argon can be blown into the tundish through argon inlet to prevent nozzle from Clogging ( specially designed feature wherever it is required we design and customise accordingly)

#### **SPECIAL FEATURES:**

- o Facility for gas purging
- o Anti oxidant properties
- o Design and size as per customer's requirement
- o Clogging free casting for long sequence of casting
- o Gas purging facilities to prevent alumina clogging (optional)
- o Slag zone immersed part re-reinforcement with special material for long life
- o Argon sealing purging arrangement can be provided on customer's request
- o Wide range of formulation for withstanding oxidation and long sequence casting
- o Different assembly methods for assured security even in long sequence casting
- o We manufacture Silica free Oxy-bore ladle shroud for less corrosion and long sequence casting

## Recycling slide gate plates to save costs and reduce waste

### The top 5 ladle shroud manufacturers in China

### Production and application of isostatically pressed refractory materials

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<https://www.futmetal.com/> 这个网址做了很多别的网页链接

## JS Bin - Collaborative JavaScript Debugging

sequence casting

o Different assembly methods for assured security even in long sequence casting

o We manufacture Silica free Oxy-bore ladle shroud for less corrosion and long sequence casting

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## 5 Key Factors Behind Ladle Shroud Cracking

Operators often see cracks and damage in ladle shrouds, long nozzles, and refractory parts. This happens because of a few main reasons:

- Fast temperature changes can cause thermal shock and peeling.

- Mechanical stress comes from handling, hitting, or working forces.
- Hot slag and molten steel can wear down and get into the parts.
- Material problems like tiny holes or mistakes made during making.
- Issues with design, how things line up, or how they fit together.

Knowing these reasons helps teams stop corrosion, breaks across the part, and chemical damage. This helps ladle shrouds last longer.

## Key Takeaways

- Quick temperature changes can cause thermal shock. This can crack ladle shrouds. Heating slowly and checking the temperature can stop this damage.
- Mechanical stress from moving and using parts can cause cracks. Storing parts carefully and handling them right helps lower this risk. Installing them the correct way also helps.
- Hot slag can wear down and get into refractory materials. This makes them weaker. Using strong materials and checking slag conditions can protect the parts.
- The [quality of materials](#) is important. Good raw materials and careful making of parts help stop cracks. Having the right amount of porosity makes parts stronger and better at handling shock.

- [Good design and alignment](#) lower stress and stop leaks. Smooth shapes and tight fits help keep ladle shrouds and nozzles strong. Checking them often also helps.

## 1. Thermal Shock

### Temperature Changes

When the [temperature changes](#) quickly, it puts stress inside refractory materials. During ladle preheating, the working layer gets hot on one side and stays cool on the other. This big difference in temperature causes strong pulling stress at the top of the working layer. Sometimes, this stress can get as high as 39.06 MPa. Damage often starts at the top and near the sidewall burner nozzles. If the ladle heats up too fast, alumina-magnesia castables get stiffer but weaker. The material turns more brittle and can break more easily. When steel is poured, the ladle shroud faces sudden heat, which also builds up stress.

**Tip:** Teams should watch temperature changes during preheating and pouring. Using thermal imaging cameras can help find hot spots and uneven heating. These signs show where cracks might happen.

### Crack Formation

Thermal shock cracks show up a lot in high-temperature furnace linings and steel ladles. These parts go through fast heating and cooling many

times. When the temperature changes too quickly, the refractory grows or shrinks more than it can handle. If the material is brittle, especially under 1100°C, cracks form easily. Big parts, uneven heating, and outside forces make cracking worse. Changes in the material's structure can also raise the risk.[isostatical pressed refractory](#)

- **Common scenarios for thermal shock cracking:**

1. Ladle preheating with fast temperature rise.
2. Steel pouring with sudden molten metal exposure.
3. Quenching or cooling steps in steelmaking.
4. High-temperature furnace linings in steel, cement, glass, and ceramics.

Thermal shock can cause early failure with small and large cracks.

Operators often see pieces breaking off, falling apart, and cracks along the [ladle shroud](#) and nozzle. Checking often and tracking temperature changes helps teams stop damage before it gets worse. Using materials that handle thermal shock better and heating slowly can help lower the chance of cracks. [Slide gate plate](#)

## 2. Mechanical Stress

### Handling Damage

Mechanical stress often starts when workers do not handle parts carefully. Sometimes, workers drop or hit the ladle shroud by mistake. This can chip, crack, or even break it before use. Teams may forget how important good storage is. If the storage area is wet or rough, the refractory gets weaker. This makes it easier to crack later.

Operators should do these things to stop handling damage:

- Keep ladle shrouds in dry, clean places.
- Teach workers to lift and move parts the right way.
- Check each part for chips or cracks before using it.
- Heat the ladle shroud slowly so it does not crack.

**Tip:** Handle parts with care and heat them slowly. This helps stop early cracks and makes the ladle shroud last longer.

### Operational Impact

Mechanical stress keeps happening when the equipment is used. Taking off coatings or moving the ladle shroud can hurt the refractory. Forces between the upper nozzle and ladle bottom can cause stress. These forces come from heat changes, steel shell growth, and heavy loads.

These types of mechanical stress often cause cracks or bending:

- Pulling forces from blocked thermal expansion.
- Pushing forces that make the part bend for good.
- The steel shell grows wider and faces thermal shock.

The table below shows how these forces can hurt the structure:

<b>Distortion Force / Cause</b>	<b>Effect on Structural Integrity</b>	<b>Mechanism / Description</b>	<b>Mitigation / Design Considerations</b>
Thermal gradients (radial differences)	Radial cracks in refractory plates	Expansion/contraction causes tensile and hoop stresses	Optimize design, use tough materials, control cooling rates
High bolt preload on cassette assembly	Rare radial cracks in plates	Bending stresses from bolt tightening and expansion	Adjust bolt tightening, improve cassette shape
Thermal contraction during cooling	Radial cracks from inner bore	Cooling causes tensile stress in Y-direction	Slow, uniform cooling
Mechanical stresses from vertical loads	Transverse and radial cracks in middle plate	Compressive stresses from molten steel cause tensile stresses	Increase preheating temperature and operation time
Crack formation and oxidation	Corrosion, leakage, steel quality degradation	Cracks allow air ingress, causing oxidation and contamination	Use anti-oxidizing additives, improve composition
Connection type	Stress distribution and stability	Conical induces tensile stress; butt works under compression	Select connection type based on

(conical vs butt)			expansion and load limits
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Operators who know about these stresses can pick better materials.

They can also install parts better and lower the chance of cracks.

Checking often and lining up parts right helps keep steelmaking equipment strong.

### 3. Slag Erosion

#### Slag Penetration

Hot slag attacks the outside of [ladle shrouds and nozzles](#). The molten slag moves over the refractory and brings heat and chemicals. These things break down the material. Slag penetration happens when liquid slag gets into small pores and cracks. This changes the inside of the refractory and makes a weak layer. That weak layer can break apart easily.

- Slag temperature and thickness decide how fast slag moves in.
- Chemical reactions between slag and refractory make new compounds.
- Pores and the inside structure let slag get in and spread.
- Molten steel and slag flow scrape the surface and cause more erosion.

- Chemical, mechanical, and heat attacks together make the damage happen faster.

Operators often see melting at the slag line and deep cracks on the sides. The slag line gets soft and weak, so pieces can fall off. Checking often helps teams find early signs of slag penetration. They can fix problems before big damage happens.

**Note:** Picking refractory materials with fewer pores and using coatings can slow slag penetration. This helps the parts last longer.

## Thermal Peeling

Thermal peeling, or spalling, hurts the sides and slag line of ladle shrouds and nozzles. Fast temperature changes during tapping or when steel flows out make the surface expand and shrink quickly. This stress causes the material to crack and flake off.

- High slag temperature and fast reactions make peeling more likely.
- Big temperature changes cause thermal shock and lead to spalling.
- Mechanical shock from scrap charging and steel flow causes scraping.
- Oxidation and rough surfaces make the refractory even weaker.

- Damage shows up as cracks, flakes, and rough spots at the slag line.

Chemical attack and slag damage happen when the refractory dissolves or makes new compounds after touching molten steel or slag. These changes make the material weaker and easier to crack. Operators should pick refractories that resist chemical attack. They should also use surface treatments to protect against slag erosion.

**Tip:** Watching slag temperature and flow, and using strong refractory materials, helps stop thermal peeling and side wall cracking.

## 4. Material Quality

### Manufacturing Defects

Material quality is very important for how long [ladle shrouds and nozzles](#) last. Cracks often begin because of mistakes made during manufacturing. These mistakes can happen from using bad raw materials or errors in making the parts. Operators notice more cracks when impurities like  $K_2O$  and  $Na_2O$  are in the material. These impurities make stress inside the part and make sintering worse. If the part shrinks unevenly while drying or firing, cracks can form. This happens when the mix or particle size is not controlled well.

Problems in the process can cause even more trouble:

- If materials are not mixed well, weak spots appear.
- Low pressure during molding leaves empty spaces inside.
- Firing at the wrong temperature or with uneven heat causes stress.
- Cracks can show up during preheating, firing, or cooling.

**Tip:** Teams should pick good raw materials and watch every step.

Mixing, molding, and firing must be done carefully to stop cracks.

## Porosity Effects

Porosity means there are tiny holes in the material. Porosity changes how the part handles heat and stress. More porosity helps the part take thermal shock better and not crack. But too much porosity makes the part weaker and easier to wear out. The table below shows how porosity changes important properties:

Material Property	Relationship with Porosity
Thermal Shock Resistance	Increases with porosity
Volume Density	Decreases with porosity
Strength	Decreases with porosity
Wear Resistance	Decreases with porosity

Operators need to balance porosity for the best results. They can change particle size and binder amount to control porosity. New ideas like nanotechnology and self-healing refractories help make parts stronger

and stop cracks. Smart refractories with sensors let teams watch for cracks in real time and act fast.

**Note:** Checking parts often and using strict quality rules helps find problems early. This makes ladle shrouds and nozzles last longer and keeps work running smoothly.

## 5. Design and Alignment

### Ladle Shroud Alignment

It is very important to line up the ladle shroud correctly. This helps stop cracks and leaks. If the design has sharp corners or tricky shapes, stress builds up there. These spots can get microcracks, mostly at grain boundaries in the refractory. If the ladle shroud is not straight up and down, or if gaskets get squished, pressure is not even. This makes weak spots where cracks can start and spread. Even small mistakes in alignment can let molten steel leak out. Leaks make damage happen faster and the ladle shroud does not last as long.

**Tip:** Make designs with smooth curves, not sharp corners. Always check that the shroud is straight when you install it. This lowers stress in the part.

A good ladle shroud design has smooth changes and strong support. This helps it handle heat and force better. Teams should use tools and

look closely to make sure the shroud is straight and tight. Checking often helps find small problems before cracks show up.

## Fitment Issues

Fitment problems can clog the nozzle and add stress. If sleeves, plugs, or blocks do not fit tightly, they move around. This movement puts stress on the ladle shroud or nozzle and can cause cracks. Thin refractory parts, like sleeves under 30 mm, break more easily. Using too much or too little mortar also makes joints loose or too tight. This raises the chance of cracks.

Nozzle clogging happens when solid inclusions, like alumina, stick to the nozzle. Many things can make clogging worse:

1. Carbon refractories lose carbon at high heat.
2. Gas forms on the nozzle surface.
3. Inclusions stick because of energy changes.
4. Lower temperatures let inclusions stick.
5. Turbulence from early clogging makes it worse.

Operators can lower these risks by:

- Making sure all parts fit tightly.
- Using the right amount of mortar.

- Picking thicker, stronger refractory shapes.
- Watching for early signs of clogging and stress.

Common Fitment Issue	Resulting Problem	Prevention Method
Misaligned shroud	Stress, cracks, leakage	Use alignment tools, visual checks
Loose joints	Movement, cracking	Proper mortaring, secure fit
Thin sleeves (<30 mm)	Higher crack risk	Use thicker components
Poor gasket installation	Stress concentration, leaks	Careful assembly, quality gaskets

**Note:** Training and careful assembly help teams avoid mistakes. This stops cracks and clogging from happening.

Steel plant teams deal with five big problems. These are thermal shock, mechanical stress, slag erosion, material quality, and design flaws. Each problem makes the ladle shroud and nozzle wear out faster. It also makes leaks more likely. Teams should check for cracks often. They can use ultrasonic and eddy current testing to find cracks early. Operators need to watch downtime and keep track of production. They should plan regular maintenance to stop problems before they get worse. The table below shows how steel flow rate and damage change how long parts last:

Steel Flow Rate (tons/min)	Typical Lifespan (furnaces)	Main Damage Causes
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~4.5 - 4.6	5 - 10	Perforation below neck, slag line erosion
~6.0 - 7.5	3 - 10	Perforation below neck, block detachment

Teams can stop leaks by making sure parts line up right. They should use good materials and control temperature during work. Fixing problems early and checking for cracks helps parts last longer and keeps downtime low.

## FAQ

### What causes most ladle shroud leaks?

Leaks usually start at cracks. These cracks come from thermal shock, bad alignment, or slag erosion. Most leaks happen at the slag line or near joints that are not lined up right. Steel plants say over 60% of leaks begin in these places.

### How can teams detect early cracks in nozzles?

Teams use ultrasonic or eddy current tests to find small cracks. These tests help spot cracks before they get bigger. Workers also look at parts often. Many plants take photos of cracks to plan repairs better.

## Does material choice affect crack resistance?

Yes, it does. High-quality refractories with fewer pores resist cracks more. Plants using denser materials have up to 30% fewer failures.

Picking the right material makes parts stronger and helps them handle thermal shock.

## Why does nozzle clogging increase cracking risk?

Clogged nozzles cause uneven pressure and stress. This stress can make cracks or leaks. More cracks show up when inclusions block the nozzle, especially when steel flows fast.

## What maintenance steps help prevent cracking?

Teams should check parts often and line up shrouds carefully. They need to control heating rates. Using logs and photos helps track wear.

Plants with strict maintenance plans have longer part life and fewer leaks.

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