

# High Performance Hydrogen Annealing in Cold Roll Coils

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**ABSTRACT:** In most of the steel industries cold roll coils is anneal because without anneal cold roll coil is not applicable for most of the application. It is heat treatment that alters the physical and sometimes chemical properties of material to increase its ductility and reduce hardness. Work hardening, & relieve the inter molecular stresses annealing is done. Thus the workability of the coil increases. Heat transfer agent is HYDROGEN. It involves heating a material to above its recrystallization temperature, maintaining a suitable temperature, and then cooling. The Major Components Of The Hydrogen Annealing: The heating hoods ,the cooling hoods ,the inner covers, the work bases, the cooling covers , electrolysis plant, hydrogen storage bullets.

**KEYWORDS:** Hydrogen Annealing, Cold roll coils, anneal steel.

## I. INTRODUCTION

In hydrogen annealing, atoms migrate in crystal lattice and the number of dislocations decreases. leading to the change in ductility and hardness. In the cases of copper, steel, silver and brass used annealing. Heat transfer agent is hydrogen because :

- Molecular weight of hydrogen is 2 which is 7 times lighter than other gases such N<sub>2</sub>.
- Hydrogen is reducing agent, so no oxidation and no scale formation.
- Less power is consumed by the base fan.
- Hydrogen generated conveniently by electrolysis of DM water.
- Thermal conductivity of hydrogen is high.
- Safety techniques of handling hydrogen have been successfully developed and implemented.

Basics process steps:

1. Coils loaded.
2. Inner cover set.
3. Inner cover clamping.
4. H<sub>2</sub> valves tightness test.
5. Inner cover tightness test.
6. Initial N<sub>2</sub> purge.
7. Setting of heating hood & firing.
8. H<sub>2</sub> purging.
9. Actual H<sub>2</sub> injection/Heating & Soaking

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10. Hot tightness test.
11. Furnace cooling.
12. Cooling with cooling hood.
13. Cooling with cooling hood + bypass cooling.
14. Final N<sub>2</sub> purge.
15. Removal of cooling hood.
16. Unloading of the base.

First of all cold roll coils is loaded on the base. Inner cover is set on the base and clamping the inner cover after the proper loading. H<sub>2</sub> valves tightness test in this 30-40 mbar pressure is applied for 30 seconds. after inner cover tightness test. N<sub>2</sub> is purge initially for removing oxygen which is present in inner cover. setting of heating hood and firing according to grade of cold roll coils. H<sub>2</sub> gas is purging for heat transfer. then heating and soaking. after hot tightness test furnace is cooling with cooling hood and bypass cooling. N<sub>2</sub> is purge for removing H<sub>2</sub> gas which is inner cover. removal of cooling hood and unloading the base.

## II. LITERATURE REVIEW

Gas Annealing Method:

Real work on annealing process is as follow: start Coils stacked on the annealing base. Inner cover set by shop crane. cooling water supply is connected for the rubber seal on the base. flow switch allows locking of inner cover. Clamping of inner cover take place by push button or automatic. Tightness test of H<sub>2</sub> valve is for 30 sec after this H<sub>2</sub> valves tight signal is generated. Checks on pressure transducers and limit switches for correct initial positions. Nitrogen to be sent inside & pressure Of 25 mbar, to be reached in 30 seconds. If the pressure of 25mbar is not reached then assembly is not tight alarm generated. after 30 seconds pressure should be 40mbar if not then 'tightness test aborted' alarm is generated. if pressure drop should not below 25mbar then Base tight signal is generated. both N<sub>2</sub> inlet & outlet valves are opened, & N<sub>2</sub> purge starts. bypass fan is started. 5 m<sup>3</sup> of nitrogen enters the cover. base fan is accelerated by the frequency converter to 520rpm. N<sub>2</sub> purging complete in 19 minutes. Bypass fan is switched off. And gate of O<sub>2</sub> content below 1% , 44 m<sup>3</sup> of N<sub>2</sub> must have entered and base fan operates at 520rpm. Interlock system releases burners for ignition. 'Heating Hood Ignition' Button Is pressed. Heating hood starts. N<sub>2</sub> inlet valve closes & H<sub>2</sub> inlet valves open i.e H<sub>2</sub> purge starts. Bypass fan starts. after 60 minutes N<sub>2</sub> should be completely displaced by H<sub>2</sub>. i.e. H<sub>2</sub> purging should have been complete. Base fan gradually accelerated to 2100 rpm. Bypass fan Is stopped. Real H<sub>2</sub> Injection Commences. Annealing start.

In the following graph, first temperature is ramping from 0 to 570 °C with time range 0 to 6 hours. After the ramping temperature is heating from 570 to 650 °C with respective to time range 6 to 11 hours. Hydrogen injected for annealing is taken out and burnt through the special burner.

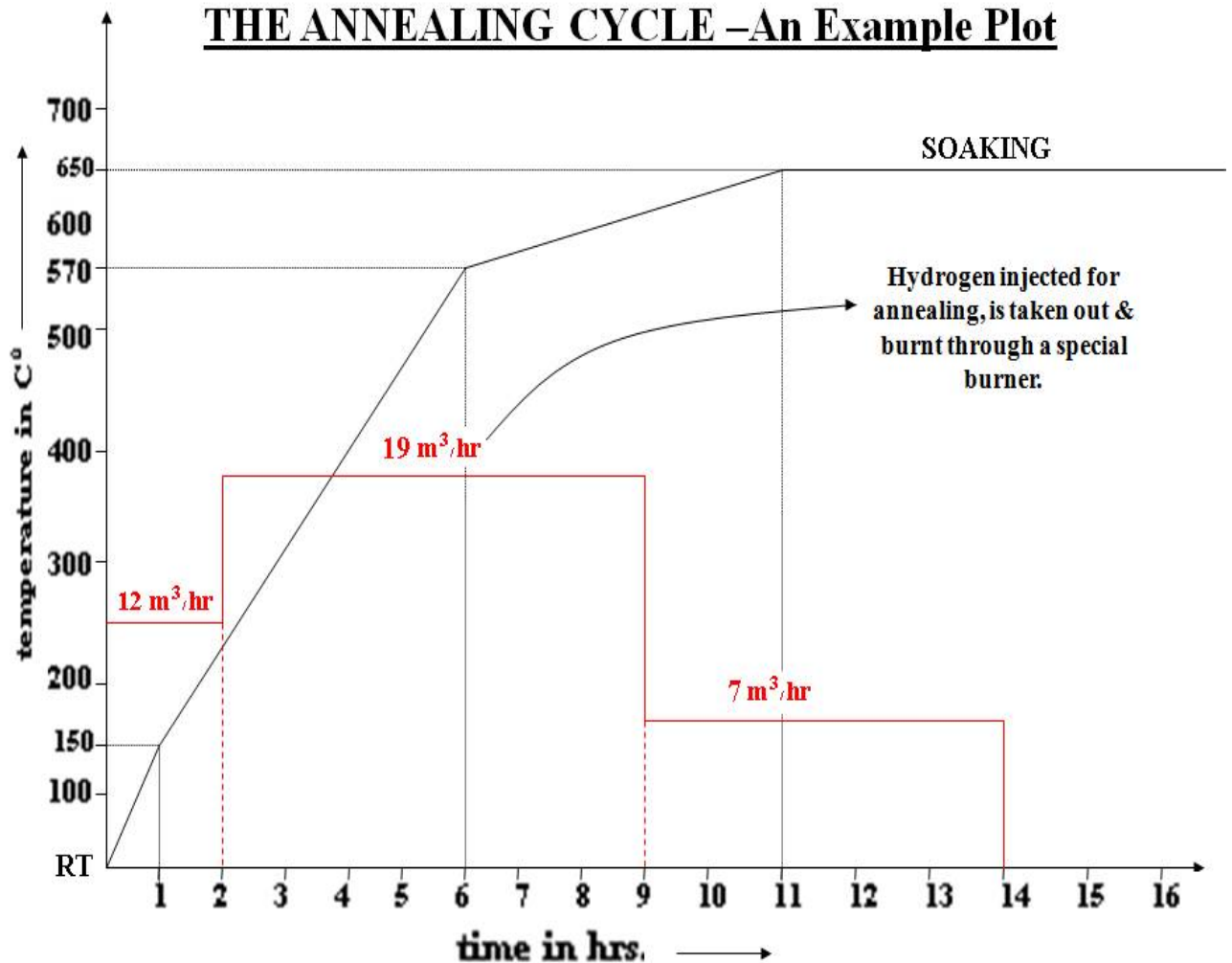
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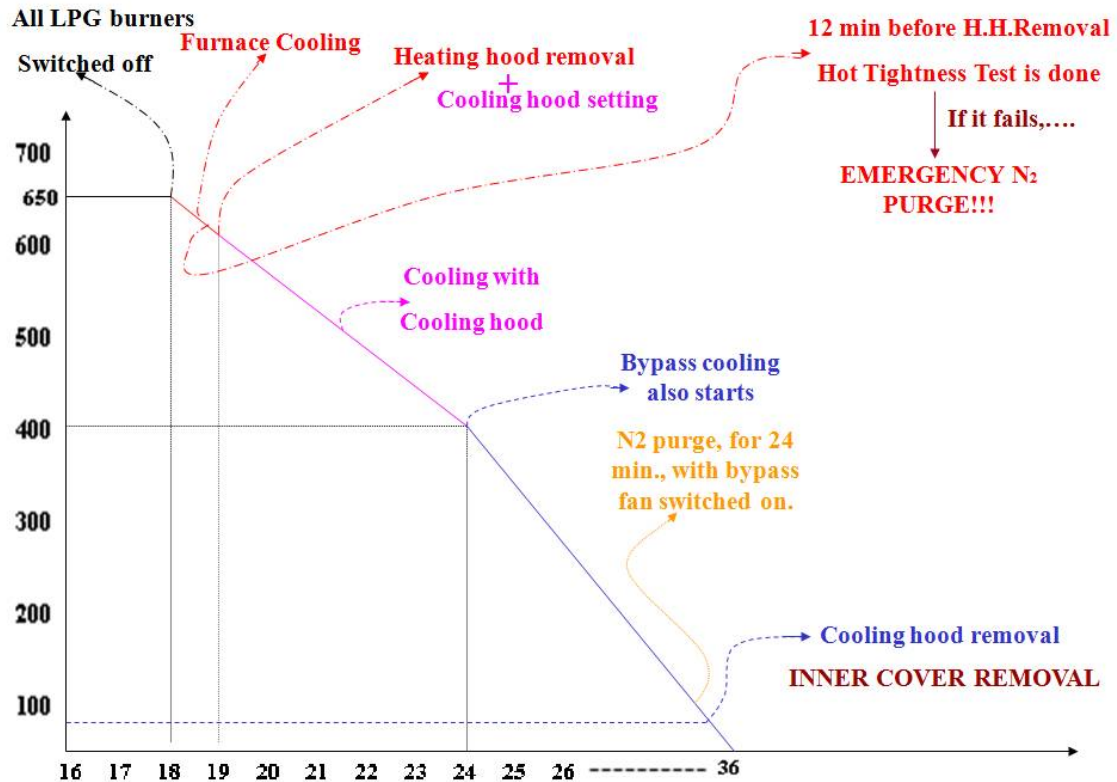
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### THE ANNEALING CYCLE –An Example Plot



After this temperature is 650 °C constant with time range 11 to 18 hours. this process is Soaking process. In soaking process burner is constant burnt for constant temperature maintaining. after completion of soaking all burner is switched off. Furnace cooling for 1 hour. Heating hood removal and cooling hood setting after 1 hour. 12 minutes before the heating hood hot tightness test is done. If it fails emergency N2 gas is purge. If not then cooling with cooling hood with time range 19 to 24 hours. Bypass cooling also start. N2 gas is purge for 24 minutes after bypass fan is on. After the completion of 36 hours, cooling hood removal and Inner cover removal.



### III. BURNER IGNITION SYSTEM & TEMPERATURE CONTROL

- 12 burners in all. 6 on top row & 6 on bottom row.
- Ignition is controlled from the PLC.
- All the 12 burners get ignited at the same time. 11 out of these are pure LPG/Natural gas burners. One is a Hydrogen burner.
- Hydrogen sent inside during the annealing cycle, burns through combustion here.
- Each burner is equipped with automatic ignition & ionization monitoring.
- The hydrogen burner has UV monitoring system.
- A solenoid valve arrangement lets LPG/Natural gas out.
- If burner fails to ignite, burner failure is indicated, & can be started once again if reset.
- When control temperature has been reached,
- Top row - ON/OFF mode,
- Bottom row - ON mode.
- If annealing cycle reaches a stage where the top burners need to be shut down,
- Bottom burners - ON/OFF mode.
- This way the temperature inside is controlled.

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## IV. BURNER CONTROL

### Burners

The primary functions of burner systems are as follows:

- Controlled fuel delivery.
- Controlled combustion-air delivery.
- Controlled fuel and air mixing.
- Controlled and reliable ignition.
- Evacuation of combustion products.
- Controlled emissions.

Regardless of fuels fired, the burner system must reliably perform all functions listed above. Choice of fuels burned and type of burner affects the ease of achieving optimal results.

#### Gaseous fuel fired

- Natural draft burners.
- Balanced draft burners.
- Induced draft burners.
- Forced draft burners.

#### Flame Ionization Principle

Heat in the flame causes the molecules in and around the flame envelope to collide with one another. The force of the collision frees some of the outer electrons of the atoms forming the molecules. This creates free electrons and positive ions, allowing a very small current to be conducted through the flame. The whole process is called Flame Ionization.

Within the flame there is very low conductivity and resistance can vary from 100,000 to 100,000,000 ohms. Current conducted through the flame (flame current) is generally in the range of 2-4 micro amps.

#### Ultra-Violet Flame Detection

Flame scanners operating in UV wavelength use an ultra-violet detection tube. In this type of system the flame is considered present when UV radiation is detected. Differentiation or discrimination between the targeted flame and neighboring flames or background, is achieved by discriminatory scanner sighting.

## V. CONCLUSION

We have implemented details process of Hydrogen Annealing of cold roll steel with interlocking of each other with alarm and safe process. Annealing is batch process which required automation using PLC for accuracy in process. we also implemented burner automaton or ignition and control using Ionization principle and Ultra violet detectors.

Result For Different Grades Of Steel:

Types Of Steel Grades	Heating Time (hours)	Cooling Time (hours)	Highest Temperature
D Grade	17	22	700°C
EDD Thicker	20	23	700°C
EDD Critical	33	35	700°C

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