



Accelerated Cooldown

Fast and Economical:

Using either our “Once-Through” or *NiCool*® cooldown methods, Praxair Services, Inc. (“Praxair”) can save you many hours and even days of cooling and purging time during your maintenance turnaround on refinery process units that incorporate fixed bed catalytic reactors including, hydrocrackers, hydrotreaters, and reformers, where catalyst handling is often a critical path activity.

Before any catalyst work can be performed on these units, the reactors must be cooled to ensure process and personnel safety. Refineries commonly use recycle compressors to recirculate nitrogen or process gas through reactors and early in the procedure, relatively cool gas (120 to 150°F) entering a hot reactor (600°F) provides rapid cooling of the vessel and contents. However, this rate cannot be sustained as the reactor

cools below 300°F and the temperature differential diminishes, Praxair can sustain the rapid cooling rate using the capabilities of nitrogen pumping equipment to perform a Once-Through or *NiCool* service. During a Once-Through cooldown, cool nitrogen gas is pumped through a reactor and vented after one pass through the reactor. In the *NiCool* method, liquid nitrogen is injected into the recycle gas stream to cool the gas before the gas enters the reactor. This technique requires about 1/3 the amount of nitrogen as a Once-Through cooldown.

With proven performance in both our Once-Through and *NiCool*® cooling methods, we have the experience and skill to safely assist your reactor cooldown projects and our highly trained team will work with you to properly design, plan and execute a cooldown project that is the best option for each reactor.

Once-Through Reactor Cooldown Service

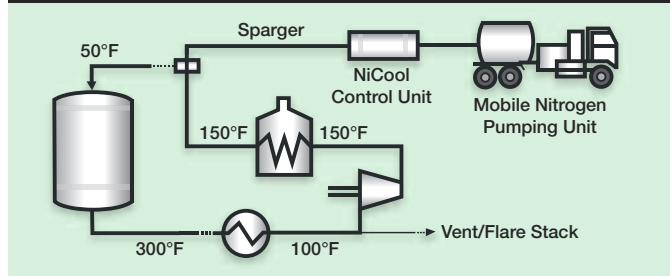
- Cools reactor below 100°F in less time than unassisted cooldown.
- Initiated when unassisted cooldown rate slows as reactor temperature nears 300°F.
- Piping rearranged for nitrogen flow through reactor to remove heat and vent to atmosphere (flare stack).
- Nitrogen pumping unit generates high flow rate of cool gas (50°F).
- Cooldown rate controlled by varying nitrogen flow rate and temperature.

NiCool® Reactor Cooldown Service

- Cools most reactors to less than 100°F in 8-18 hours and is highly effective.
- Uses recycle compressor to provide high flow rate of gas which is cooled to 50°F by injecting liquid nitrogen into the gas recycle stream.
- Highly efficient: requires about one-third the amount of nitrogen as Once-Through, uses both sensible heat of gas and latent heat of vaporization of liquid.
- Recommended for large reactors requiring multiple pumping units.
- NiCool® service equipment designed for proper control of cooldown process and automatically stops the injection of liquid nitrogen in the event of low temperature at the injection point or system malfunction.

Specifications:

Cooldown with NiCool® Liquid Nitrogen (LN₂) Injection

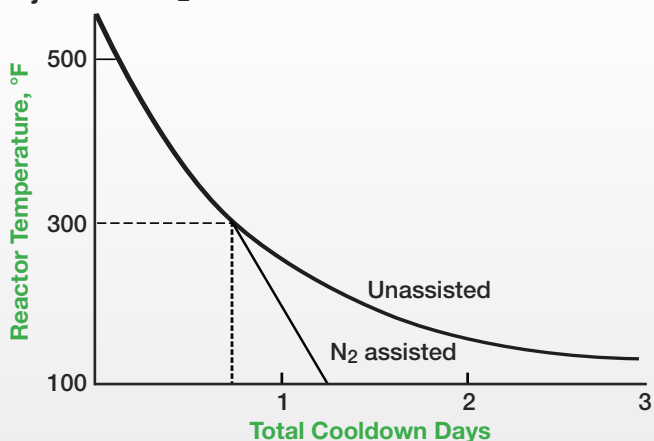


- NiCool service employs a computer program to model reactor system including the gas recirculation capabilities to predict liquid nitrogen injection rate, volume, and time required for cooldown.
- A custom injector nozzle (sparger) installed in the reactor feed piping is designed to minimize cold spots and ensure good mixing when necessary.
- Using the existing recycle compressor to provide a high gas recirculation rate, liquid nitrogen is injected

into the recycle gas stream ahead of the reactor, and the combination of high-flow rate and cool gas produces accelerated cooldown.

- NiCool service equipment is designed for automatic, proper control of the cooldown process given specified cooldown rate.
 - Controls liquid nitrogen injection rate to maintain specified cooldown rate.
 - System automatically shuts down in event of low injection temperature or system malfunction.
- Skin thermocouples at injection point are used as inputs to NiCool service control system.
- Selection of injection point and injector design are critical.

Cooldown time is dramatically shortened by injection of N₂



NiCool Vs. Once-Through Comparison

NiCool® Cooldown

- Nitrogen volume 1.6MM SCF
- Injection rate 175,000 SCFH
- Nitrogen gas (-320°F)
- Cooldown time 9 hours

Once-Through Cooldown

- Nitrogen volume 6MMSCF
- Injection rate 400,000 SCFH
- Nitrogen gas (50°F)
- Cooldown time 15 hours

Applications:

- Fixed bed reactors of all types – especially reformers, hydrotreaters and hydrocrackers – can be rapidly, safely and inexpensively cooled using NiCool service.
 - Cools most reactors to less than 100°F in 8-18 hours.
 - Requires about one-third amount of nitrogen as traditional cooling methods.
- We properly plan and design your cooldown project and exercise appropriate operational controls.
- Praxair has the experience, training, and skills to complete NiCool reactor cooldowns safely and efficiently.



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