

Integration of Supercritical Carbon Dioxide Cooling Loop for G3P3 Primary Heat Exchanger

Introduction

The Generation 3 Particle Pilot Plant (G3P3) is currently under construction and includes a supercritical carbon dioxide ($s\text{CO}_2$) cooling system to remove heat from a particle-to- $s\text{CO}_2$ primary heat exchanger (PHX) to evaluate the behavior of this technology for concentrating solar power (CSP) applications. The $s\text{CO}_2$ cooling system consists of a centrifugal pump, an $s\text{CO}_2$ -to-air cooler, one stainless steel recuperator, and one nickel alloy recuperator as the main components of the loop. This poster describes the cooling system and integration plans with the overall G3P3 system.

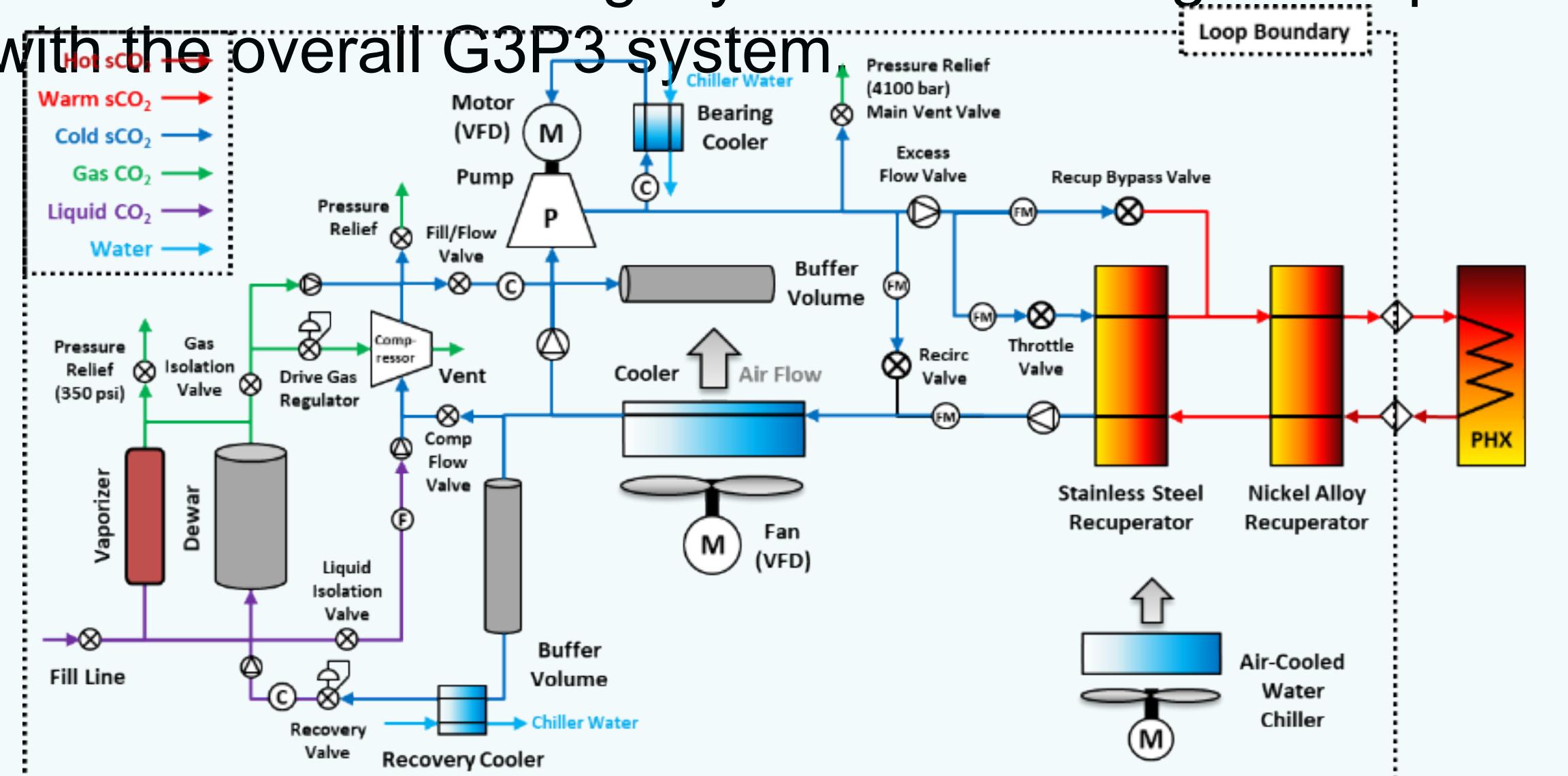


Figure 1. G3P3 Supercritical Carbon Dioxide Cooling Loop Flow Diagram

Table 1. G3P3 Supercritical Carbon Dioxide Cooling Loop Requirements

Requirement	Value
Operating Fluid	Carbon dioxide
PHX outlet pressure	250 bar
PHX outlet temperature	715°C
Thermal duty	$\geq 1 \text{ MW}_{\text{th}}$
Operational time	16 hours/day

Major Components

The G3P3 Cooling Loop consists of major components including:

- Centrifugal Pump
 - A single-stage centrifugal pump is being used as the flow circulator and will be controlled via Variable Frequency Drive (VFD).
 - This pump is capable of a flow of 100 gallons per minute (5.3 kg/s) which support the need of the PHX of a 1MW_{th} cooling rate.
- Air to $s\text{CO}_2$ Air Cooler
 - A 1.2 MW_{th} Stainless-Steel Printed Circuit Heat Exchanger (PCHE, currently in fabrication) paired with a 64,000 ft³/min of air flow serves as the main cooling system.
- Recuperation System
 - Two PCHEs are used as the recuperation system.
 - A 1MW_{th} nickel-alloy recuperator (Inconel 617) is used as the component to interface with the particle-to- $s\text{CO}_2$ primary heat exchanger (PHX).
 - A 3MW_{th} stainless-steel recuperator pairs with the nickel-alloy recuperator for this system.

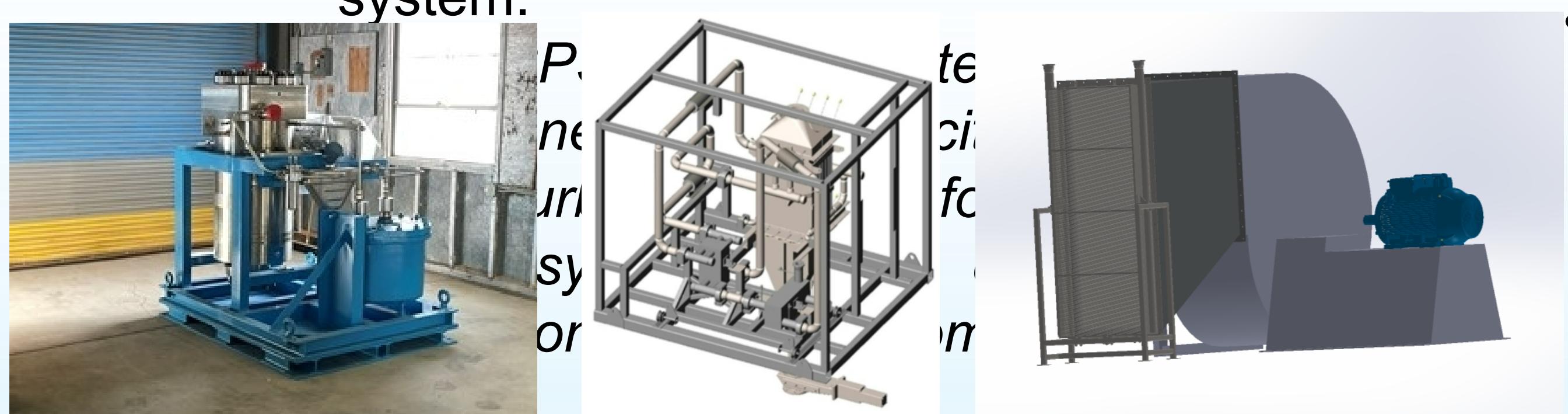


Figure 2. Images and Models of Major Components; Left, Pump; Center, Recuperation System and PHX; Right, Air Cooling System

Other Components

- Instrumentation System
 - A central instrumentation system has been constructed and contains instruments to monitor and control equipment like VFDs, control ball-valves, Venturi and Coriolis flowmeters, Resistance Temperature Detectors (RTDs) and pressure transducers.
- Piping and Connectors
 - Piping ranges from sizes 1.5 to 3 NPS and schedule 160 to XXH.
 - Most connectors are Grayloc connectors selected due to size and ease of installation.

Integration and Installation

Upon completion of the G3P3 tower construction, the components will be installed on the levels as planned by the G3P3 project.

- Third Level
 - Circulation Pump and Air Cooler
 - Heaviest equipment of cooling loop
 - Instrumentation System
- Fourth Level
 - Recuperation System
 - Co-location with PHX to decrease high temp piping
- Ground Level
 - Inventory System (dewar)

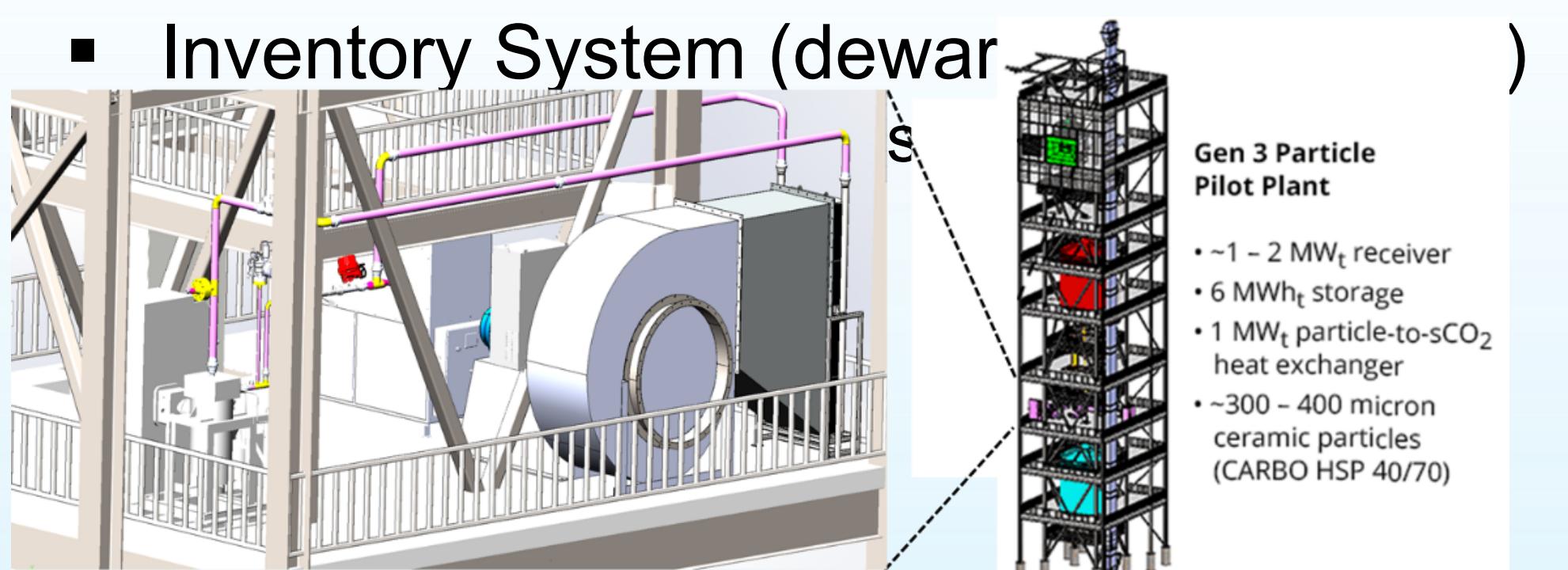


Figure 3. G3P3 System and General Arrangement of Cooling Loop in Tower