19953

Ceramic Reinforced Metals Provide Superior Corrosion Resistance and High Temperature Strength.

1. Impact

Transitioning to 700-750°C can dramatically reduce the size of required tanks, HX, and pump systems (reducing construction cost), while increasing thermodynamic efficiency (decreasing operating costs) of CSP plants.

2. Project Goal

Manufacture a prototype HX for demonstration and test - technical goals include:

- Flexural strength σ, 300-400MPa
- Flexural modulus E, 50-125GPa
- Thermal Conductivity k, >50W/mK at 750°C
- Salt and sCO2 corrosion <0.2 mm/year
- Lifetime operation >30,000hr at 750°C

3. Method(s)

Apply Powdermet's HybriTherm and HybriMet high temperature, low corrosion, load-bearing thermally-conductive metal matrix composites to high-temperature heat exchangers.

thermal conductivity			
	W/mK 50°C	W/mK 800°C	relative conductivity ratio
goal		50	
HTIN 25Di	21	52	3.3
HTIN 35Di	42	54	3.4
HTHN 25Di	32	52	3.3
HTHN 35Di	53	87	5.4
NiWC3b	25	39	2.4
H230	9	16	control

Table 1. All development materials exceed the thermal conductivity goal

Mechanical Properties					
	tensile strength, σ	tensile Modulus, E	compressive yield 0.2%	compressive modulus	flexural strength
	Mpa	Gpa	Mpa	Gpa	Mpa
goal	300-400	50-125			
HTIN25Di			650	40	
HTIN35Di			650	35	
HTHN25Di			1175	50	
HTHN35Di			1250	60	
NiWC3b	1019	425	2644	379	1182
H230	838	209			

Table 2. HybriTherm cermets have higher tensile and compressive strength than superalloys

4. Outcome(s)

Have compounded, molded and measured four HybriTherm cermets with thermal conductivity over 50 W/mK at 800C and up to 5.4 times the thermal conductivity of Haynes 230.

Completed a preliminary design for prototype HX fabrication and tests.

5. Conclusion/Risks

Connection of the HX to the balance of the system emerged as an important issue to be addressed to enable testing our prototype HX at UWisc and to provide a production design. A task addressing brazing of super alloy tubing to cermet and pressure testing the joint at Brayton was added to our project.

6. Team

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Figure 1. Powdermet's pilot plant can scale up and build the heat exchanger