Mechanical Engineering
School of Engineering & Applied Sciences

FutureME 2024 Conference

Washington State University Tri-Cities

2710 Crimson Way, Richland, WA 99354

Friday April 26th, 2024

8:00 AM – 1:00 PM

East Auditorium

Conference Organizer

Dr. Messiha Saad

Conference Chair

Dr. Changki Mo

Conference Officers

Dr. Joseph Iannelli, Dr. Yuxin Zhang, Dr. Che-Hao Yang

Keynote Speaker

"Left Turns, Right Turns, and U-Turns –

Careers in Mechanical Engineering"

Presented by

Gary Hickman
Chair, ASME-Columbia Basin Section (CBS)

Distinguished Speaker

"Engineering and the Hanford Tank Waste Mission"

Presented by

Karthik Subramanian
Chief Engineer, Washington River Protection Solutions (WRPS)

Guest Speakers

"ANS and Your Future"

Presented by

Consuelo Guzman-Leong
Chair, ANS-EWS

"ASME and Your Future"

Presented by

Janice Parker
ASME - Student Section Operations

Sponsors: ASME Columbia Basin Section, ANS-EWS, and WSU Tri-Cities Student Section

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Time (PDT)	Topic
8:00 – 8:30 AM	**Coffee & Donuts** **Introduction & Welcome** Changki Mo, Conference Chair Messiha Saad, Conference Organizer
8:30 – 8:45 AM	**Sustainable Filament:** **Harnessing Lignin's Potential in 3D Printing** Samantha Grade
8:45 – 9:00 AM	**Advances Toward Robotic Pollination** Ezekyel Ochoa
9:00 – 9:20 AM	**Keynote Speaker** **"Left Turns, Right Turns, and U-Turns –** **Careers in Mechanical Engineering"** Gary Hickman Chair, ASME-Columbia Basin Section (CBS)
9:20- 9:40 AM	**Distinguished Speaker** **"Engineering and the Hanford Tank Waste Mission"** Karthik Subramanian Chief Engineer, Washington River Protection Solutions (WRPS)
9:40- 9:50 AM	**Guest Speaker** **ANS and Your Future** Consuelo Guzman-Leong Chair, ANS-EWS
9:50- 10:00 AM	**Guest Speaker** **ASME and Your Future** Janice Parker ASME - Student Section Operations
10:00 – 10:20 AM	**Poster Presentation – SEAS Design Expo (Location: Atrium)**

10:30 – 10:45 AM	**Filter Media Solid-Liquid Separation Method** Vitaliy Rizin, Rafael Moreno Soto, Trevor Peterson, Mary Workman
10:45 – 11:00 AM	**Passive Ventilation System Design for SST** Rodrigo Ruiz, Valerie DuBois, German Anguiano, Johnny Romero
11:00 – 11:15 AM	**Variable Analysis of Offset Strip Fin Geometry for Compact Heat Exchangers** Jamie Hamilton, Noah Clift, Kevin Lam
11:15 – 11:30 AM	**Former Design of a Superconducting Magnet for Rotary Magnetocaloric Liquefaction** Kyle Gurule, Dan Hamilton, Derek Bauer
11:30 – 11:45 AM	**Fatigue Analysis - Canister Rinse Vessel** Maksim Karazhbei, Braxley Myers, Anthony Cromwell
11:45 – 12:00PM	**DIY Dual Heat Exchanger Cooling System** Jason Crosen, Kelli Kilpatrick, Juan Martinez, Noel Quintero
12:00 – 12:15 PM	**Solar Powered Refrigerator for Milk Transport** Pascal Elsinghorst, Erick Martinez Mora, Marcos Salas, Josh Romero
12:15 – 1:00 PM	**Lunch**
1:00 – 1:15 PM	**Closing Remarks**

Sustainable Filament:
Harnessing Lignin's Potential in 3D Printing

Samantha Grade
Faculty Advisor: Dr. Che-Hao Yang

Additive manufacturing, commonly known as 3D printing, is a rapidly advancing technology that enables the creation of intricate geometric structures with unprecedented freedom. Researchers are actively exploring the integration of lignin and cellulose nanofibers (CNF) into PLA-based materials for biocomposite filaments, with the goal of enhancing mechanical and thermal properties. This study focuses on investigating the effects of varying lignin and CNF content on the material's properties, including mechanical strength, thermal stability, and compatibility with the polymers. Additionally, this research delves into optimizing cross-linking agents such as Tetramethyl Tetraphenyl Trisiloxane (TTT) and Tetraethoxysilane (TEOS) to improve 3D printability and sustainability. Understanding how these additives interact with the polymers and influence the overall performance of the biocomposite filaments is crucial for advancing the field of sustainable additive manufacturing.

Advances Toward Robotic Pollination

Ezekyel Ochoa
Faculty Advisors: Dr. Changki Mo

The aim of this thesis is to design and investigate the feasibility of a sandwich PVC foam and glass fiber reinforced composite accumulator container for the Zurich University of Applied Sciences 2023 race car. Considering that weight has a detrimental effect on the performance and efficiency of an electric race car, this thesis serves as a guide for the weight reduction objective set by the ZHAW race team. A newly designed accumulator container is modeled in SolidWorks and simulated in SolidWorks Simulation using finite element analysis. Several loading scenarios are simulated to achieve an optimal balance between weight and strength. A low-weight and high-strength container is a top priority during the testing and design phase. The phase following this includes work for the benefit of next year's team. The geometry of the container is described in detail, and the optimizations developed in the context of this thesis are explained.

Filter Media Solid-Liquid Separation Method

Vitaliy Rizin, Rafael Moreno Soto, Trevor Peterson, Mary Workman
Faculty Advisor: Dr. Joseph Iannelli
Sponsor: Framatome - Fuel

Time and involvement are two things that raise costs in any commercial application. Commercial processes can be iterated hundreds of times. Reduction in the time and involvement in one iteration can drastically impact cost over time. In the case of this project, a drum, which was filled with used filter media and water, must be processed so that water is removed resulting in dry filter media within the drum. The design problem was approached with safety, cost, and operator involvement in mind. The objective of this project was to design and construct a full-scale prototype of a water removal process that meets the customers' needs. The customers' requirements structured the process for determining the top design concept as well as the standards and codes that would be used. The design utilizes a dehumidification process to extract water from the filter media. The dehumidifier exhaust and intake are connected to the drum, creating a closed system. This allows hot dry air to cycle through the drum, which is an ideal condition for evaporation. The analysis of the design showed that as water is extracted from the drum, the rate of extraction becomes slower. The full-scale prototype has a small footprint, it minimizes operator involvement, and with additional modification, faster dry time can be achieved. Future modifications to the design could include increasing the surface area of the filter media by putting the drum on its side or adding a mixing mechanism that allows the water-saturated filter media at the bottom of the drum to be cycled to the top. These modifications to the design can reduce the dry time.

Passive Ventilation System Design for SST

Rodrigo Ruiz, Valerie DuBois, German Anguiano, Johnny Romero Kyra
Faculty Advisor: Dr. Messiha Saad
Sponsor: WRPS (Doug Reid & Ted Wooley)

Washington River Protection Solutions (WRPS) has tasked Washington State University (WSU) to develop a passive ventilation system to increase air flow through the risers on the single shell tanks (SST) on the Hanford site. To accomplish this task, the WSU team had to first develop conceptual designs that could be placed over the filter used on the SST risers. The concepts must fit the requirements given to WSU by WRPS. After down selection of the designs, Computational Fluid Dynamics (CFD) testing was performed to determine a rough estimate of the flow rate through the riser. To solidify the results, the WSU team then tested the designs in a mock set up. The mock set up tried to replicate the real-world conditions the passive ventilation system would be in. The test results showed an improvement in ventilation, but further improvements can be made. The next step would be to perfect the design by finding the ideal dimensions of the ventilation system and improving the build quality of the system.

Variable Analysis of Offset Strip Fin Geometry for Compact Heat Exchangers

Jamie Hamilton, Noah Clift, Kevin Lam
Faculty Advisor: Dr. Yuxin Zhang
Sponsor: Framatome-IBPE Advanced Reactors (Andrew Porter)

This project expands the existing theory surrounding the calculation of two crucial variables, **β** (referred to as the compactness factor), and **ω** (the complement to **β**), in the design of offset strip fin compact heat exchangers. Compact heat exchangers operate with similar heat rejection and efficiency to traditional heat exchangers but in a much smaller size. Volume optimization is critical for the heat exchangers being used in modular and micro-modular nuclear power plants, which are a primary focus of the Framatome-IBPE Advanced Reactors design group. Existing research on offset strip fin design provide tabulated values for **β** and **ω** but lack any clear method of calculating these variables. Geometric analysis was performed for this type of fin, utilizing the dimensions provided by research as input to a variable output and validating against said research to within a 2% margin of error. This new methodology, based on the research from Manglik, R. M., & Bergles was developed and successfully solved for thirteen of the eighteen reference offset strip fin designs (from Kay's and London 3'rd Edition), including single, double, and triple layer-stacked fin geometries. Upon completion of this methodology, it was integrated into a specialized design tool for offset strip fin compact heat exchangers using several common coolants for nuclear applications. This design tool automates the calculation process and determines the smallest allowable heat exchanger volume that can dissipate a required heat load without exceeding the factor of safety specifications for the allowable pressure drop across the core of the compact heat exchanger and the total heat transfer from the primary to secondary side. Validation of this design tool involved matching the results of literature examples on compact heat exchangers to within a 1% margin of error. Further development includes refining the methodology to account for a greater variety of fin designs and improving the overall scale of the design tool.

Former Design of a Superconducting Magnet for Rotary Magnetocaloric Liquefaction

Dan Hamilton, Kyle Gurule, Derek Bauer
Faculty Advisor: Dr. Yuxin Zhang
Sponsor: PNNL (Corey Archipley)

Pacific Northwest National Laboratory (PNNL) is working to increase the efficiency of industrial gas liquefaction over conventional methods using Active Magnetic Regenerative Refrigeration (AMRR) based on the magnetocaloric effect. Liquified gases such as oxygen, helium, and hydrogen in liquid form are used to solve many challenges like high-density energy storage, fusion, and quantum computing. The AMRR method requires supercooled magnets with a high tesla output. PNNL has tasked us with creating a new former that will facilitate keeping these magnetic coils in place while keeping them supercooled. Our team has created a two-piece former, which will sandwich the coils between the top and bottom. This sub-assembly will be attached with connecting rods to the lid of the dewar wherein the entire system is contained. Each superconducting coil will be directly attached to the cryocooler via tabs connected to the coil winding core. Each core will be made up of multiple parts to help with the winding of the coils themselves and increase conduction from the cryocooler. The connecting rods will maximize length within the space to keep heat leaks via conduction at bay, while remaining short enough to keep the former stable. Materials choice will be crucial as we evaluate the balance between strength, weight, and thermal conductivity.

Fatigue Analysis - Canister Rinse Vessel

Maksim Karazhbei, Braxley Myers, Anthony Cromwell
Faculty Advisor: Che-Hao Yang
Sponsor: Bechtel (Bryan Dunlap)

This project aims to work alongside Bechtel representatives to validate the structural integrity of the HDH-VSL-00001 canister washdown vessel located at the Hanford Vit Plant. The purpose of this vessel is to temporarily contain, wash down, and transport a canister containing vitrified nuclear waste. The defined passing requirement for the vessel is to withstand cyclic loading of 10,000 lbs. applied by the weight of the canister being lowered in and out of the vessel for 40 years of predicted operation. The Rainflow Counting Method will be used in ANSYS to perform a fatigue analysis on the vessel. This project involves interpreting vendor drawings, 3D modeling in SOLIDWORKS, preparing the model for simulation in ANSYS (modifying geometry, applying load combinations, boundary conditions, material properties, etc.), and adhering to American Society of Mechanical Engineers (ASME) Boiler Pressure Vessel Code (BPVC), Section VIII, Division 1.

DIY Dual Heat Exchanger Cooling System

Jason Crosen, Kelli Kilpatrick, Juan Martinez, Noel Quintero
Faculty Advisor: Dr. Changki Mo
Sponsor: ENERCON (Chad Hendrix)

The objective of this project was to create a DIY dual heat exchanger cooling system. The completed system will be used to introduce how heat exchangers work, all while attracting students during STEM week at local schools. This showcase serves to entertain and inspire young students to see the concepts and work that can be done in the world of engineering. Our progress explains the researched design components to meet our client's needs. Two of the primary focuses consist of two heat exchangers and a water pump. The heat exchangers will increase our temperature drop while the heating element is on. This heating element represents the heat generated by nuclear fuel rods. The water pump keeps a consistent flow to ensure enough water is running into the heat exchangers and back into the reservoir. The integration of a control relay, water flow meter, and temperature sensors with an LCD will track the progress of the system. Being able to test our final outputs was critical in checking our theorized percentage error. Following current real-world design aspects to ensure our final design can operate our system requirements like flow rate and heat transfer. We also explain our main component decomposition and house of quality breaking down the requirements of our client and how our system comes together to meet those requirements, while also explaining why we ended up choosing those design components. The final system is designed to be user-friendly and easy to assemble, using two storage containers for easy transportation.

Solar Powered Refrigeration System for Milk Transport

Pascal Elsinghorst, Erick Martinez Mora, Joshua Romero, Marcos Salas
Faculty Advisor: Dr. Changki Mo
Sponsor: Dr. Mark Kinsel; Agriculture Information Management, Inc.

The objective of this project is to develop a cost-effective product designed for cooling milk to 38°F in the bed of a pickup truck. Client specifications include a battery powered by solar power, 10-gallon liquid volume storage, and a platform for solar efficiency optimization. Through various design iterations and tests, our system includes a refrigerator enclosed within a wooden container powered by a 50Ah battery capable of sustaining power to the refrigerator for approximately 16 hours. Solar efficiency can be optimized by positioning the solar panel's surface normal-to the sun's direction. Through implementation of linear actuators, a solar panel can be rotated on a central axis and then positioned normal to the sun vertically. To better understand the amount of power needed to sufficiently cool various gallons of milk, up to 10, thermal simulations using COMSOL were conducted. Along with power calculations done to meet the given requirements. The final design includes an enclosure that has two separate compartments: one for the fridge and a smaller one intended to store the electrical components that consist of a battery, solar charge controller and inverter. The enclosure is designed with ventilation holes to ensure air circulation within the system. The next development step is to optimize the design and functionality based on the outcomes from this prototype.