### Project Overview: Funding, Participants, and Objectives

**Program:** Phase II Small Business Innovation Research (SBIR)

**Funding:** Overall project budget: $1,050,000 (including DCA funding)

**Overall Project Performance Dates:** March 18, 2020 - March 16, 2022 (24 months)

**Project Participants:**
- Media and Process Technology
- Teclaya Consulting

**Overall Phase II Project Objectives:**

1. **Eliminate** operation mode, **success:**
   - 200

2. **Advanced Carbon Molecular Sieve (CMS) Membranes**
   - 700
   - 10

3. **Azeotrope Break:** MeOH Conversion
   - MI-03-Obj4

4. **Membrane Reactor Subsystem:** Enhanced DMC Conversion in MR Configuration
   - MI-03-Obj5

5. **NF Subsystem:** Exceptional MeOH/DMC Separation
   - MI-03-Obj6

**Results:**

1. **Membrane Reactor Subsystem:** Enhanced DMC Conversion in MR Configuration
2. **NF Subsystem:** Exceptional MeOH/DMC Separation

**Process Flow Diagram:**

- **Integrated MR and NF Subsystems**
- **Membrane Reactor**
- **Membrane Separator:** MeOH/DMC
- **Operating Conditions**
- **Reaction Time**
- **DMC Concentration**

**Accomplishments:**

- **Demonstrated DMC production cost ~$0.27/lb**

- **High temperature (>500°C, 300 to 1,500 psig)**

- **High pressure (1,500 psig)**

- **Wide range of membranes technologies**

- **Multiple tube bundles**

- **High temperature (>500°C)**

- **Hard sealing**

- **Stable MR Membrane**

**Technology:** Advanced Carbon Molecular Sieve (CMS) Membranes

- **Package into Multiple Tube Bundle**

**Background:** Direct Synthesis of DMC: Advantages & Challenges

**Advantages of Direct Synthesis of DMC**

1. **Green Process:** Produced from CO₂ and biomass derived methanol
2. **New Technology:** Reactors are mimicked diatom structure yielding high selectivity
3. **Safety:** Considerably safer operating conditions than commercial processes.

**Challenges of Direct Synthesis of DMC**

1. **Extraneous limitation:** Conversion to DMC limited to under 2 to 5%
2. **Membrane Reactor:** Multiple membrane reactors required.
3. **Energy intensive:** Combination of these problems yields an economically unviable process.

**Solution:** Membranes in DMC Synthesis and Recovery

- **Membrane Reactor: In-situ Dehydration**
- **Membrane Separator: MeOH/DMC Separation**
- **Membrane Reactor Membrane Separator: Inorganic Non-Aggressive MR Technology**

**Operating Conditions**

- **120 to 200°C, 300 to 2,100 psig**
- **Nanofilter Performance**
- **Membrane Reactor Membrane Separator: Inorganic Non-Aggressive MR Technology**

**Results:** Membrane Reactor Subsystem: Enhanced DMC Conversion in MR Configuration

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