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## ***Creative Engineers, Inc. – Lithium Experience***

### ***Background of Creative Engineers, Inc.***

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Creative Engineers, Inc. (CEI) was formed in 1996 as a chemical process engineering company specializing in alkali metals. The founders of Creative Engineers, Richard VanLieshout and Kevin Berry, have extensive experience with alkali metals such as lithium, potassium, sodium, NaK (sodium potassium alloy), and potassium superoxide. This is partly because of their work at a former BASF facility outside of Pittsburgh, PA, where they were responsible for the engineering and operations of all alkali metal processing areas. This facility is the world's largest manufacturer of these products (NaK, potassium and potassium superoxide).

Seeing a need for specialized alkali metal engineering, CEI was formed. CEI's three principals have over 75 years combined experience working with lithium, NaK, sodium, potassium, and potassium superoxide as process engineers, project engineers, manufacturing managers and engineering managers.

### ***Experience with Lithium Systems***

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Over the years, CEI has built and operated several lithium test loops ranging in size from one liter to 200 liters. To meet customer requirements, loop temperatures have been as high as 800 degrees C, and loop vacuums as low as 0.001 torr.

One growing industry trend is the ever-increasing demand for lithium purification. CEI has experience in several types of purification including filtration, hot traps, cold traps, and bulk thermal oxide traps.

Within the CEI facility in New Freedom, PA is a lithium loop that is used for testing pumps, flow meters, and other devices. The loop can be used to test customer-supplied equipment, or for testing the electromagnetic (EM) pumps and flow meters, manufactured by CEI.

Since the CEI facility handles lithium and other alkali metals, it has the required permits for working with large quantities. The facility was built with the proper construction techniques, fire and spill control. This skill and experience is also used to help CEI customers properly design their facilities.

### **Lithium Hydride**

CEI worked with one customer on the development of a process to convert lithium hydride to lithium oxide. The project involved the safe receipt, storage and handling of lithium hydride followed by reaction of the hydride with a controlled oxygen source. CEI created the process, designed and build the system, operate the experiments, and reported data and results back to the customer. The objective was to take a highly hazardous material and change its form while preserving the resource of the component parts of lithium hydride.

### **Argonne National Laboratory**

After conducting a number of experiments related to lithium, the engineers at Argonne National Laboratory hired CEI for decommissioning activities. The system had some tricky mechanical considerations which also created additional safety hazards. CEI developed specific procedures that were effective and safe, and assisted with the cleanup of all residual lithium and NaK (sodium/potassium alloy) from several components in the system including control valves, tubing, instrumentation, and a small storage tank. CEI worked within numerous facility, procedural, and safety constraints to help develop the process and complete the project.

### **Lithium Purification**

CEI was chosen to design, build, and operate a lithium purification system based on the concepts originally developed by the customer. Using many years of practical experience in alkali metal systems, CEI refined the original concepts and developed the distillation/condensation system that was designed for continuous operation. The operating temperatures were in excess of 500 degrees C and vacuum was maintained at fractions of a torr. The system was operated at the CEI facility in York, PA, utilizing a foot print of approximately 150 square feet and 10 feet high. The system was fully contained in an argon purged environment.

### **Lithium Dispersion Research**

CEI designed, built, and operated a novel dispersion system to disperse an alkali metal into a volatile liquid hydrocarbon. The system precisely dispensed the liquid hydrocarbon and the liquid alkali metal into a dispersion pump to create the dispersion. The resultant dispersion was chilled and captured into a collection tank of approximately 20 gallons. Because of the hazardous nature of the

experiment, the entire system was construction within a sea container and connected to essential power and other utilities within the CEI facility in New Freedom, PA. A second sea container provided the personnel control room safe location, main control panel, electrical components such as dispersion pump variable frequency drive, and other devices not suitable for locating in the processing area.

## **BASF**

The Callery Chemical location of Mine Safety Appliances was purchased by BASF in 2003. Several CEI employees were involved in processes and systems that used lithium at the facility. Products used in the R&D laboratory as well as the pilot plant included elemental lithium metal, lithium hydride, and butyl lithium.

## **Lithium Dispersion Production**

CEI is a regular manufacturer of sodium dispersion through a joint venture with KMR Industries, but some customers require special dispersion formulations using non-standard oils or other specific requests. For this purpose, CEI has the ability to use a small-scale (15 gallon or 75 gallon) pilot system at the facility in New Freedom PA. CEI has manufactured a lithium/oil dispersion for one such customer using this pilot system.

## **NASA**

To support NASA's space propulsion programs, CEI was selected to work with NASA engineers and scientists to research and prepare detailed methods of purifying lithium metal. CEI went on to design and build an alkali metal purification system for NASA to use with lithium, sodium and NaK.

## **Lithium Batteries**

CEI designed and built a fill station to inject liquid lithium and other components into a battery housing as a test of a scale up towards full scale production.

In another project, the engineers at CEI designed a small scale system to fit a confined space to feed liquid lithium to a CVD system, one of the key pieces of equipment used in battery production.

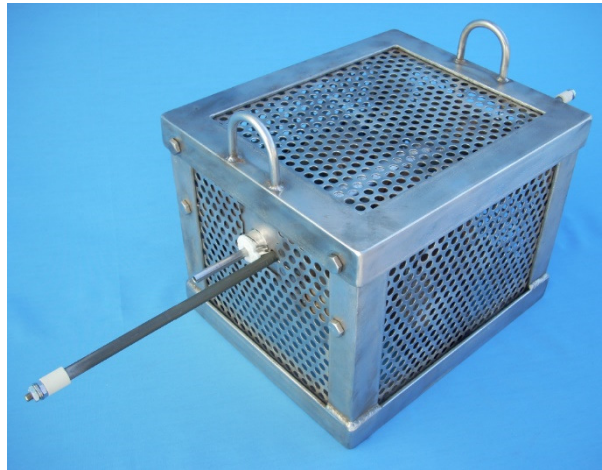
## **Lithium Recycling**

To support the recycling efforts of one of our customers, CEI worked on a process that achieved conversion of lithium recycle material to lithium hydroxide for eventual recycling back to lithium metal.

### *Additional Creative Engineers, Inc. Capabilities*

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Creative Engineers, Inc. (CEI) has expanded its core capabilities to include other services. CEI is one of the few manufacturers in the world of electromagnetic (EM) pumps. These pumps are unique and have no moving parts and no seals. EM pumps are used for pumping alkali metals and other fluids with very high conductivity properties.



In addition to EM pumps, CEI also designs and manufactures EM flowmeters and high temperature pressure transmitters.

CEI designs and fabricates skid-mounted chemical handling and processing systems that are shipped to many parts of the world. For some customers, CEI also operates the customer's pilot plant at our facility in New Freedom Pennsylvania. The systems range from all manual to fully automatic processing using PLC or PAC control from leading providers such as Allen Bradley and National Instruments.