1-1-2007

Pneumatic Capsule Pipeline

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DOI: 10.5703/1288284315871

PNEUMATIC CAPSULE PIPELINE (PCP)

THE NEED

Pneumatic capsule pipeline (PCP) uses wheeled capsules (vehicles) to carry cargoes through a pipeline filled with air.

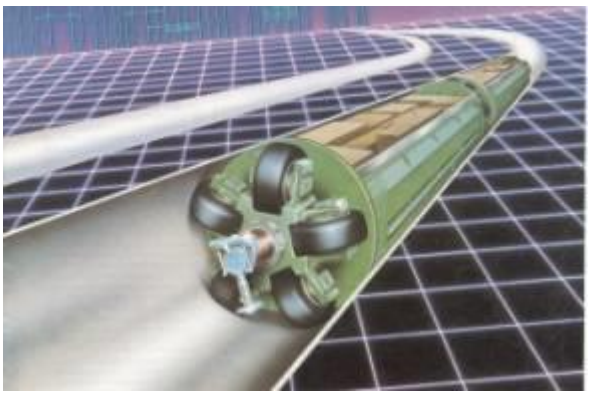

FIGURE 1 PCP WHEELED CAPSULE (DRAWING BY SUMITOMO METALS)

The air is used to push the capsules through the pipeline. For a PCP of 3-foot diameter, each capsule can carry about two tons of cargo, traveling at 25 mph approximately. Because the capsules travel at 25 mph non-stop, they move at approximately the same daily average speed of trucks. High-value products, such as mail and parcel, can be transported by PCP.

Simple PCPs follow conventional fluid mechanics principles. Air is blown down and / or extracted from the pipeline, propelling the capsule along the pipe. The two ends of the pipe are always open, and the pressures on both ends are atmospheric. Air is blown through the pipe by a blower near the intake of the pipe.

THE TECHNOLOGY

Short PCPs involve a limited number of capsules in the system at any one time (normally just one train of several cars). This reflects the inefficiency of creating sufficient pressures to propel multiple capsules, and the difficulty in retrieving one capsule from the end of the pipeline while a second capsule was being propelled.

Modern large diameter PCP systems utilize through flow booster pumps, also known as jet pump injectors. These create the pressure differentials required to propel multiple capsules through a pipeline, while allowing both terminals at atmospheric pressure.

http://dx.doi.org/10.5703/1288284315871

This is done by placing a booster pump midway along the pipeline, and designing it in such a way that capsules can bypass the pump. Larger diameter pneumatic systems were developed by the Victorians as an alternative to underground railways, carrying freight and passengers underground in cities.
During the 1960s and 1970s large diameter pneumatic systems were further developed as a potential technology for high speed ground transportation.

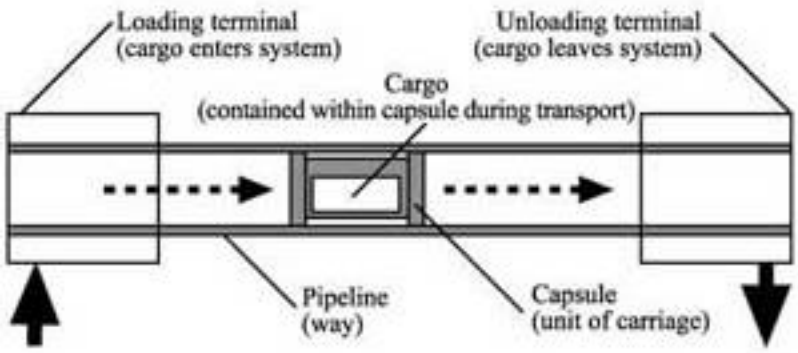

FIGURE 2 PCP AS TRANSPORT SYSTEM (DRAWING BY SUMITOMO METALS)

Since mid 1960s, there have been many researches and application trials in US, USSR, and UK. these countries attempted to find markets for their technologies for decades. Since 1980s, however, Japan has played a major role in this area, and showed the efforts in applying the technology to real cases. In most cases, horizonal systems were applied. There are two successful horizontal systems used in Japan, by the Sumitomo Metal Industries. One of the two systems is for transporting limestone to a cement plant, using 1m diameter circular pipe since 1983. Another is used for construction of a long tunnel for bullet trains, using square cross section made of precast concrete panels.

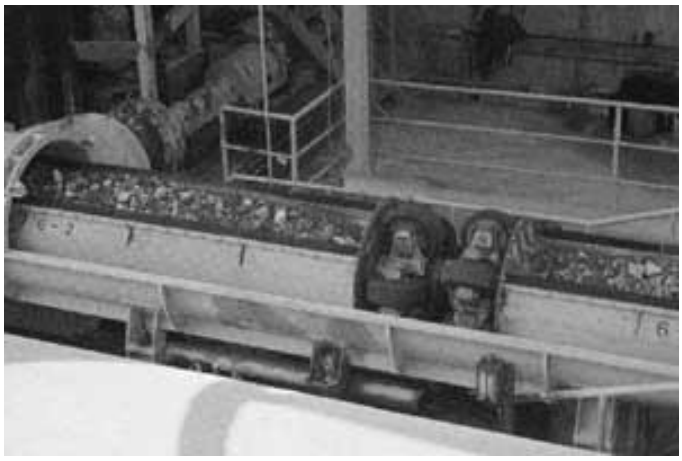

FIGURE 3 PCP SYSTEM IN OPERATION (COURTESY OF KAJIMA CORP & SUMITOMO METALS)

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Recently, one of the industry leaders, Tokyo-based Sumitomo Metals, has succeeded in applying PCP technology vertically in a soil removal project. In November 2001, Sumtomo implemented the first vertical application for a PCP, successfully removing soil from a sewage tunnel in Hiroshima, Japan under collaboration with Kajima Corporation.

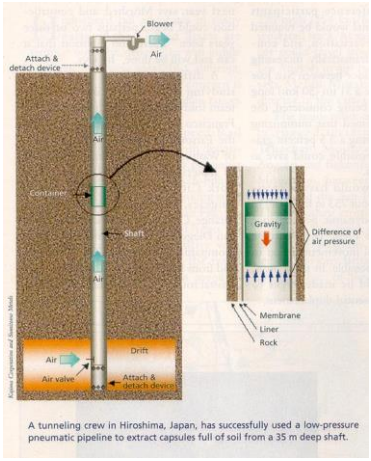

FIGURE 4

In this application, the railed vehicles travel in a chain of five along a horizontal tunnel track until they reach the 1 m diameter, 35m long vertical steel shaft. A capsule receives soil at a loading station and inserted into the pipeline one at a time. Once the capsule-equipped with four equally spaced plasitc wheels at each end of a central axis-is in the pipeline, a suction blower at the top of the pipe immediately launches it to the surface. The shaft can transport as many as 30 capsules an hour, each with a volume of 1m3. The low-pressure air current created by the suction blower can transport 51 Mg of material an hour with approximately 200kW of power.

Recent proposed applications range from the distribution of household goods, mail or refuse, to inter-city or inter-continental freight movement. Movement of passengers might also be possible.

BENEFITS

Use of PCP reduces the reliance on trucks for freight transportation. With fewer trucks on highways and streets, traffic congestion, accidents and air and noise pollution will all be lessened. Because PCP technology uses underground pipelines powered by electricity, it does not contribute to highway congestion, is very safe, and is non-polluting. Furthermore, PCP is far more reliable than trucks, uses less energy, is weather-proof, theft-proof and strike-proof. It also gets cargoes to destinations sooner than trucks. It can be used for transporting hundreds of cargoes that are ordinarily carried by trucks, such as mail, grain, vegetables, packaged products, bottled milk, boxes of cans, etc. Therefore, use of PCP in the future for intercity transportation of freight has vast implications for the nation and the world.

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STATUS

Capsule Pipeline Research Center (CPRC) was established at Univ. of Missouri - Columbia in 1991 to study and develop new pipeline technology for underground transportation of freight. The Center received funding from the National Science Foundation (NSF) as a State/Industry University Cooperative Research Center (State/IUCRC) for eight years, the longest period of funding for such centers. Many companies in the US, Japan, and Canada are still attempting to not only find market for this technology, but also improve the technology itself to solve the problems limiting application.

BARRIERS

Horizontal PCP

As PCP requires loading and unloading facilities, a longer distance, say a few km, is necessary for its economical application. As PCP's acquisition cost is higher than trucks because it needs pipeline construction as its guide way, a longer operational year, say a few years, is necessary for its economical application.

Vertical PCP

PCP's cost is higher than "Bucket-Wire" system if transport distance (depth) is less than 100 m

The main barrier to long-distance PCP is that the current system is not cost effective as compared to truck and train, which use existing highways and rails, respectively. To be more competitive, further improvement of the contemporary PCP systems is needed. This can be done by using electromagnetic pumps (linear induction motors) instead of blowers to power the system.

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REVIEWERS

Peer reviewed as an emerging construction technology

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PUBLISHER

Emerging Construction Technologies, Division of Construction Engineering and Management, Purdue University, West Lafayette, Indiana

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