



ELSEVIER

Available online at [www.sciencedirect.com](http://www.sciencedirect.com)

SCIENCE @ DIRECT®

Applied Energy 76 (2003) 239–246

**APPLIED  
ENERGY**

[www.elsevier.com/locate/apenergy](http://www.elsevier.com/locate/apenergy)

# Modern water hydraulics—the new energy-transmission technology in fluid power

G.H. Lim\*, P.S.K. Chua, Y.B. He

*Nanyang Technological University, School of Mechanical and Production Engineering,  
50 Nanyang Avenue, Singapore 639798, Singapore*

Accepted 1 February 2003

---

## Abstract

With the increasing demand for an environmentally-friendly fluid medium in the fluid-power industries, recent advances in water hydraulics technology have sparked renewed interest in the application of water, instead of oil, as the energy-transmission medium. This paper introduces the history of water hydraulics and its present research. The advantages and disadvantages of water as an energy-transmission medium are discussed. A water-hydraulic system in Nanyang Technological University is introduced.

© 2003 Elsevier Ltd. All rights reserved.

*Keywords:* Energy transmission medium; Water hydraulics; Oil hydraulics; Fluid power

---

## 1. History of water hydraulics

In 220 B.C., Archimedes, a Greek physicist, put forward the Hydraulic Law (the principle of buoyancy) and invented the Archimedean Screw, a device for raising water [1]. The first water pump was invented in 200 B.C. [2,3]. In 100 B.C., water-powered wheels appeared in China. Du Yu of China invented the chain mills driven by waterwheels between 265 and 420 A.D.. The first water-hydraulic press, invented by Bramah, was granted a British patent in 1795. In 1906, Williams and Janney coined in the idea of replacing water-based fluid by oil, thus avoiding corrosion, lubrication and freezing as well as leakage problems, at high temperatures, involving water. The following years saw a tremendous increase in the application of oil

---

\* Corresponding author. Fax: + 65-6791-1859.

*E-mail address:* [mghlim@ntu.edu.sg](mailto:mghlim@ntu.edu.sg) (G.H. Lim).

hydraulics. The turning point came in 1994, when fresh interest was revived in water hydraulics. This time round, with the advances in materials and designs, tap-water hydraulics was made possible. Water hydraulics technology, after being tucked away for almost half a century, has since been taken seriously. With more water-hydraulic component suppliers emerging in the world, the complete water-hydraulic system has become a reality [4]. Fig. 1 shows the applications of water and oil hydraulics.

## 2. Current research and development of water hydraulics

Water hydraulics were overtaken by oil hydraulics in the early part of the last century in terms of research effort and industrial applications [5]. In recent years, with developments in materials and machining, it is becoming possible to produce water hydraulic components that are made of lubrication-free, anticorrosive materials and achieve very close tolerances to reduce internal leakages due to the low viscosity of water [6,7]. Growing concern about environmental issues has led to renewed interest in water hydraulics. Because water is non-toxic, environmentally friendly and readily available, many industries are steadily turning to water-hydraulic systems to replace their oil-hydraulic counterparts.

Many companies are involved in water hydraulics. These include Danfoss, Hytar OY, SPX Fluid Power (former Fenner Fluid Power), Hauhinco Trading, Elwood Corporation, Hunt Valve Company, Schrupp Inc., the Oilgear Company, Hainzl Industriesysteme GmbH & CoKG, Ebara Research Co. Ltd, Kawasaki Heavy Industry Ltd., Kayaba Industry Co. Ltd., Koganei Co., Komatsu Ltd., Mitsubishi Heavy Industries Ltd., Moog Japan Ltd., Nabco Ltd., Nachi Co., SMC Co., Tokyo Precision Instrument Ltd., Yuken Kogyo Co. Ltd., and so on [5,8–17].

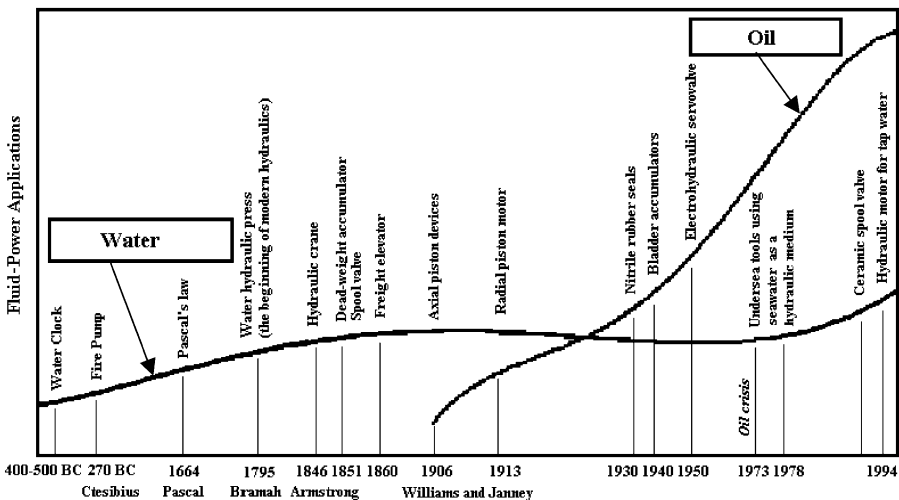


Fig. 1. Past applications of water and oil hydraulics.

متن کامل مقاله

دریافت فوری ←

**ISI**Articles

مرجع مقالات تخصصی ایران

- ✓ امکان دانلود نسخه تمام متن مقالات انگلیسی
- ✓ امکان دانلود نسخه ترجمه شده مقالات
- ✓ پذیرش سفارش ترجمه تخصصی
- ✓ امکان جستجو در آرشیو جامعی از صدها موضوع و هزاران مقاله
- ✓ امکان دانلود رایگان ۲ صفحه اول هر مقاله
- ✓ امکان پرداخت اینترنتی با کلیه کارت های عضو شتاب
- ✓ دانلود فوری مقاله پس از پرداخت آنلاین
- ✓ پشتیبانی کامل خرید با بهره مندی از سیستم هوشمند رهگیری سفارشات