Co-funded by the
Erasmus+ Programme
of the European Union

16. Ultrasonic Pump

František Kundracik

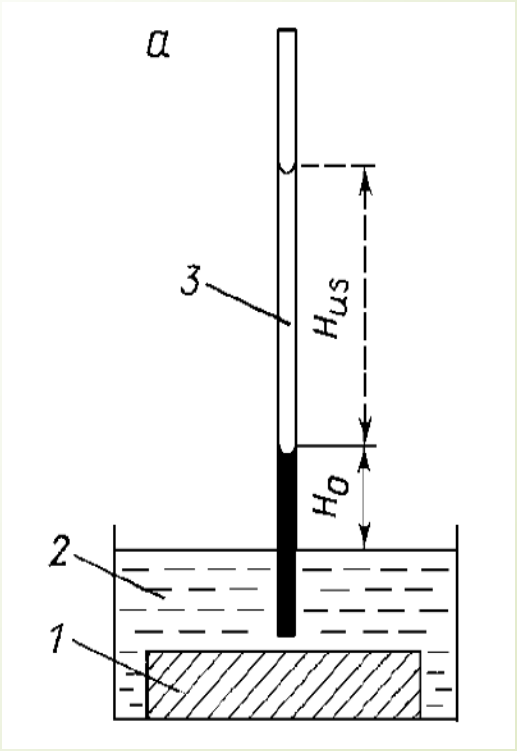
Department of Experimental Physics

Faculty of Mathematics, Physics and Informatics

Comenius University, Bratislava, Slovakia

16. Ultrasonic Pump

A capillary immersed in an ultrasonic bath works like a pump that can lift water to a considerable height. Explain and investigate this phenomenon.



Demonstration of the effect

https://youtu.be/vp2Ez3sgm-Q (1:00 - 4:30)

Ultrasound bath

- Power of 60W is mentioned in papers as sufficient to observe the effect
- Standard jewerly cleaners have the power of 50-60 W, usually without power regulation
- Dedicated sources with precise control of the power are the best

How it works?

- No detailed explanation in scientific papers
- Experimental evidence that **cavitation** plays the role (sonoluminiscence, ...)

ULTRASONIC CAPILLARY EFFECT AND SONOLUMINESCENCE

N.V. Dezhkunov[+], A. Francescutto[#], P. Ciuti[*] and P. Ignatenko[+]
+ Belarusian State University of Informaics and Radioelectronics, Minsk, BELARUS
# DINMA, University of Trieste, via A.Valerio 10, 34127 TRIESTE, ITALY
[*] *Physics Department, University of Trieste, via A.Valerio 2, 34127 TRIESTE, ITALY*
dnv@bsuir.edu.by

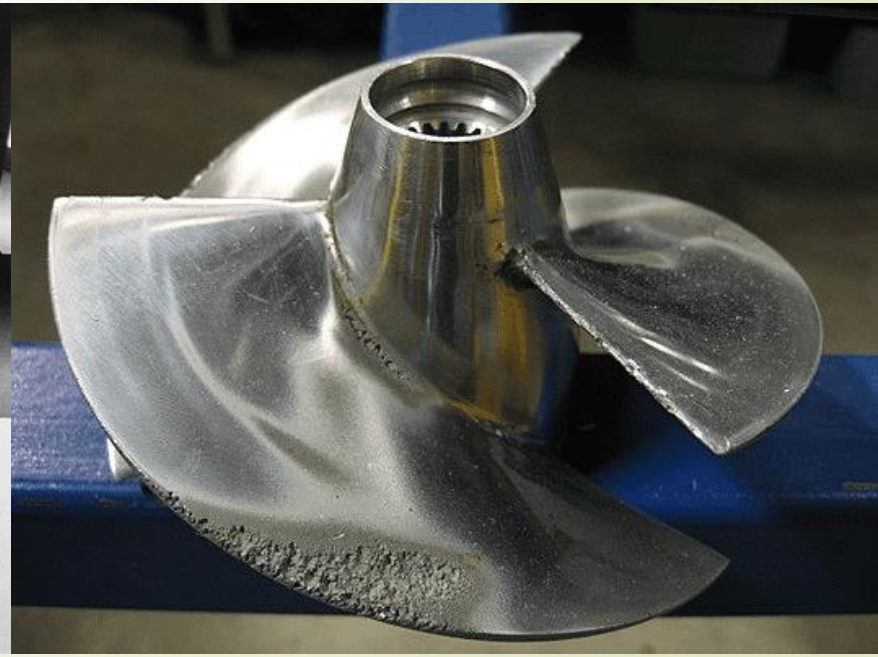
Abstract

Experimental results described in the present paper confirm the hypothesis about cavitational nature of the ultrasonic capillary effect (UCE), which is an abnormally high rise of a liquid in a capillary under

value in some cases exceeds H_0 by orders of magnitude and is much higher than could be caused by radiation forces and acoustic streaming. Ultrasonic capillary effect can be characterized by the liquid height rise H_{us} (Fig. 1a) or by the excess pressure ΔP_0

Cavitation

- Water has very low compresibility
- If the pressure goes rapidly down, unstable bubbles filled with water wapour are formed
- If the presure is returned do normal value, bubbles are collapsing and water hits strongly the surface of metal – errosion



What happens in the ultrasound bath

- Simple qualitative explanation
- Periodical change in pressure due to ultrasound waves
- Mean value of the change in the pressure is zero in compressible liquids – no special effect
- Some non-linearity must be involved to observe additional capillarity
- Cavitation:
  - Compression – high pressure
  - Decompression – negative pressure is limited by the water wapour pressure
  - Mean value of the pressure change is positive

What to do?

- Build your experimental setup, measure the pressure by the height of the water or by electronic pressure-meter, like https://techfun.sk/produkt/senzor-tlaku-mpxv7002dp/
- If you have power regulated source:
  - Measure the dependence of the height of the water in the capillary on the power: can be observed any critical power needed?
- Pressure of the water wapour strongly depends on the temperature (search in the literature) – measure the dependence of the effect on the temperature of water
- Is the material of the capillary important? Try metal, glass, hard/soft plastic, ...
- Is the diameter of the capillary important? Try various diameters.
- Try to formulate a phenomenological model

Literature

- http://www.conforg.fr/wcu2003/procs/cd1/articles/000485.pdf
- https://iypt.ru/wp-content/uploads/2020/08/An-Ultrasonic-Suction-Pump-with-No-Physically-Moving-Parts.pdf
- http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.823.5232&rep=rep1&type=pdf

Thanks for your attention