In this section of Resonance, we invite readers to pose questions likely to be raised in a classroom situation. We may suggest strategies for dealing with them, or invite responses, or both. “Classroom” is equally a forum for raising broader issues and sharing personal experiences and viewpoints on matters related to teaching and learning science.

Construction of an Electrically Sustained Rijke Tube Set-up

Resonance, [Vol.8, No.1, pp.59-71, 2003] carried an article ‘The Rijke Tube – A Thermoacoustic Device’ on the Rijke tube which explained the principle of operation and also gave details of construction of a gas heated Rijke tube. In the article below Mr Hoong describes an electrically heated Rijke tube. Editor

During my final year at the University of Leicester, I was given the task of conducting a study and construction of an electrically sustained Rijke tube phenomenon. This was to enable students and researchers to easily reproduce the Rijke phenomenon without resorting to short term gas heating of metallic gauzes or mesh.

After conducting a few experiments using the traditional method of gas heating a metallic mesh, it was concluded that the position of the mesh within the tube plays an important role. As mentioned in many research papers, the optimum position of the mesh is approximately ¼ of the total length of the tube measured from the bottom. This position produces the strongest resonance for the least amount of energy input.

The density of the mesh is another factor. This is because the effective heat transfer from the mesh to the upward air convection is proportional to the surface area of metal exposed. A dense mesh arrangement will provide more surface area for the heat transfer, but it will also impede the air flow. A coarse mesh arrangement will provide less heat transfer area, but will be less

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restrictive to air convection. A mesh size of approximately 1 mm × 1 mm provides a good balance in terms of energy transfer and convection flow. For the mesh material, a variety of materials such as brass, copper, steel and stainless steel were tried. Standard resistance heating wire mesh such as nichrome was not used as it is not commercially available. It was found that stainless steel mesh was the most suitable in terms of longevity and oxidation resistance.

Another challenge was to obtain a suitable means for electrically heating the mesh. Resistance heating was the simplest avenue, and the most cost effective. As such, a powerful step-down transformer was used. The input AC voltage was stepped down to a low secondary voltage, with a subsequent rise in secondary current capacity. With an input voltage of 80 V AC, the output current measured at the secondary was approaching 90 Amperes. This was sufficient to resistance heat the mesh to a reddish hot state.

The tube used was a 1” ID brass tubing. A relatively small diameter tubing was selected to minimise the cross-sectional area of the tube, resulting in less energy input required for the phenomenon to occur. The tube was cut at ¼ length from the bottom, and two pieces of soft ceramic seals were machined to fit the ends of the tubes snugly. The stainless steel mesh was stretched between the two seals, and a ceramic paste was applied in between to ensure air tightness. Once the ceramic paste dried, the mesh assembly was held in a phenolic laminate structure, and the appropriate electrical connections made to the transformer output. A small 12 V DC ventilation fan was installed to keep the external temperatures of the mesh assembly manageable.

A variable voltage source was connected to the input of the transformer, with an initial voltage of 80-90 V AC to start the mesh heating. As soon as the Rijke phenomenon occurs, the input voltage may decrease approximately by 30%. But the sound will continue indefinitely, as long as the mesh remains electrically heated, and the air convection is not disrupted.