

Fostering international student exchange programmes: a case study of water decontamination in Nepal

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ABSTRACT: The effect of globalisation on education and engineering education in particular, are matters of special attention and professional debate. They form an important part of international co-operative challenges. The main contribution included in this article to this effort is computer design regulation of an affordable stove for potable water for the Nepalese population. Two major environmental health risks in developing countries are addressed in this study: that of indoor air pollution and unsafe water. There is a need to stimulate thinking, research and effect change to better understand and develop critical sustainability issues, and to search for ways that would impact on engineering solutions in a global and social context. It is the view of the authors that this study may have a major impact on society by providing a solution that provides for fundamental human rights, such as sanitation, and drinking water, while at the same time reducing exposure of the population to indoor air pollution.

INTRODUCTION

Challenges and Opportunities for International co-operation on Innovation in Engineering Education

Co-operation and competition on innovation in engineering education comes from student demands to obtain advanced educational training to improve their competitive capacity and to get in touch with the globalisation of the education market. Expensive tuition fees on the other hand restrain many students from studying overseas. Therefore co-operative programmes may overcome the cost barrier. A particular case study described in this article derives from the emerging necessity of potable water, sanitisation and room heating for the rural population of Nepal.

Cooking and heating are the main household energy needs for the Nepalese population. In mountain areas, the demands of space heating are greater than the demands for cooking. In the mountain areas, 32% of the household energy is used for cooking and 56% for heating, compared with 40% for cooking and 36% for heating in hill areas [3].

Each exchange of students or staff provides a challenge and new opportunities. The case study is based on a real application and research done during three years at a Kathmandu University laboratory. After presenting the necessity of the study and the project to a group of professors at Lucian Blaga University of Sibiu (LBUS), it was clear that this problem was a great challenge because the topic presented and the research needed have a narrow direction and application. However, it is imperative that educational institutions recognise the various regional problems and from this, can provide more education on the specific environmental topics affecting those regions. The problems may be local in scale, but may require global solutions.

PIONEERING ERASMUS MUNDUS IN ROMANIA

Lucian Blaga University of Sibiu has gathered considerable experience with international co-operation in the context of academic agreements between universities around the world. International research co-operation is carried out at project level by scientific staff. It should be mentioned that LBUS joined Erasmus Mundus Mobility with Asia East and Erasmus Mundus Mobility with Asia West in 2009, being the first and only university from Eastern Europe and from Romania, specifically, accepted for the Erasmus Mundus external co-operation Windows Programmes.

Every year about 100 to 150 students from Asia come to LBUS to enrol in bachelor, master, doctoral and post-doctoral study programmes. The Erasmus students are involved in research teams, including staff members and students from LBUS - some of whom have already participated in international conferences, winning awards and publishing papers in international journals. The LBUS joined the programme with the objective of strengthening ties between education networks and academic institutions in Asia and Europe, and to promote intercultural exchanges.

NECESSITY OF THE STUDY

The purpose of the project described in this paper is to bring an affordable hot and potable water solution to isolated regions of Nepal. In Nepal, for the rural population, cooking with traditional fuels in traditional stoves and in a poorly ventilated indoor setting is, of course, not the choice, but rather a necessity. Nearly 90% of the energy requirement is still met by burning traditional biomass: fuel wood, agro-residue and animal dung.

Women spend 11 to 15 hours a day gathering fuel wood, cooking and cleaning. Still, two million of the mid-hill households' immediate cooking energy is fuel wood [3]. It should be pointed out that globally, 1.6 million people die yearly due to exposure to indoor smoke; and 1.8 million people, mostly children, die yearly from waterborne diseases, such as diarrhoea [3]. In Nepal, indoor smoke is responsible for 7,500 deaths per year, and drinking unsafe water is attributed to the deaths of 13,000 children [1].

In Nepal, the water and sanitation sector is characterised by fragmented service delivery, with multiple implementing agencies working relatively independently, many with only tenuous links to government. It is estimated that 56% of constructed schemes are fully functional. A recent study conducted by the government shows that only about 18% of the existing schemes are well functioning. National policy and strategy is considered broadly satisfactory, but problems still persist in sector co-ordination, planning, targeting the poor, sanitation practices, monitoring, knowledge management, capacity building, and scheme sustainability [4].

As an alternative opportunity, LBUS Engineering recently hosted one Masters student from Kathmandu. The objective of this visit was to test and improve the initial idea of a stove used to pasteurise drinking water in order to obtain hot potable water for the Nepalese population. The system was to be designed for a small initial cost of less than \$50, and would require no additional long-term cost to operate and maintain. It was crucial to optimise the design to come up with a kit that could be easily assembled and distributed. This particular project was developed at LBUS in three steps, as follows:

- Analysis of a stove prototype generically named the KU-3 design, its technical details and parameters;
- CATIA V5R20 software computer design of the Water Pasteurization through Improved Cooking Stove (WAPIC) system to determine long term durability of the pasteurising coil;
- Water testing for microbial removal and water pasteurisation.

In Bangladesh, Islam and Johnston used an aluminium coil as a *Chuli* system in clay to make a traditional stove to purify water, using the heat in the combustion chamber of a traditional cooking stove [5]. In Nepal, the Environment and Public Health Organisation (ENPHO) has initiated research work in combining water pasteurisation and two pothole mud improved cooking stoves for water purification.

In collaboration with WATER-AID Nepal, the Department of Mechanical Engineering at Kathmandu University started research work on WAPIC in order to determine long term durability of the pasteurising coil, to ensure pasteurisation of water during the whole cooking period and to make WAPIC's inbuilt system so that it can be easily blended in the chimney part of any Improved Metallic Cooking Stove.

Case Study: Laboratory Innovative Steps on KU-3 Prototype at Kathmandu University

Kathmandu University's Department of Mechanical Engineering has collaborated with the Alternative Energy Promotion Centre and the Energy Sector Assistance Programme (AEPC/ESAP) to select the appropriate model of metallic stove to be disseminated under a subsidy programme of the Government of Nepal in the high hill region of the rural area population living at 1,500-2,000 metres above sea level.

After extensive testing and verification, the KU-3 model was decided to be the most appropriate model to be disseminated and, thus, more than 5,000 KU-3 models already have been installed. The ESAP had a target to install an additional 7,000 such units in other parts of the country by March 2012. The KU prototype 3 mainly consists of three pot holes for cooking, a metallic body for room heating, a water tank for hot water and a grill for cooking chapatti, as presented in Figure 1.

With time, the user needs and manufacturing demands have been changed. In order to fulfil the requirements of the user and to satisfy qualified manufacturers, future research on the KU-3 Metallic Improved Cooking Stove (MICS) has been found to be necessary to improve the KU-3 MICS, based on economical considerations, water, sanitation and hygiene (WASH) issues and multipurpose use. According to a survey by a biomass engineer of the Regional Centre of AEPC/ESAP, qualified manufacturers and users who are directly using KU-3 MICS water tanks designed for hot water seem to be ineffective, costly and space consuming.

This is why the present research activities started to modify and improve KU-3 MICS by blending the WAPIC system with the chimney part of MICS. The WAPIC works when fuel is combusted in a MICS, and heat from the fire directly

heats Pothole 1. Additional heat - mainly from smoke - travels from Pothole 1 to Pothole 2 and 3 and then escapes through the chimney. The pasteurising coil is placed inside the chimney in order to utilise this excess heat from the smoke to achieve an adequate pasteurisation temperature for the water.

Specification of KU-3 MICS with WAPIC System

The basic descriptions of KU-3 MICS with WAPIC system are as follows: weight of stove 40 Kg per set (with chimney); length 675 mm; breadth 430 mm; height 260 mm; number of potholes 3; chimney diameter 120 mm; material MS 4mm top plate, 1.6 mm body; lifetime 25,000 operation hours; WAPIC System: aluminium coil 10 mm diameter, 6 m long with standard plastic bucket and mug.

The technical details of KU-3 are: average fuel wood burning rate 30 g/min; specific fuel consumption 391 g/l; fire power 10 kW; efficiency of microbial removal (E-coil) 100 %.



Figure 1: KU-3 Metallic Improved Cooking Stove with three potholes (MICS) and water pasteurisation system (the WAPIC).

Experimental Approach of WAPIC System through Computer Design

In collaboration with Lucian Blaga University in Sibiu, Romania, Kathmandu University has designed WAPIC as an inbuilt system, using CATIA V5R20 software, as shown in Figure 2. The study programme began with a computer design in order to adjust the prototype, after the main unconformities were identified. The height of the WAPIC cylinder and coil inside is 310 mm and 270 mm, respectively. The diameter of the outer and inner cylinder is 120 mm and 90 mm, respectively. The diameter of the helical coil is 10 mm with a pitch of 12 mm and the number of turns is 23.

Through the lessons learned from the first phase of laboratory testing of the KU-3 with WAPIC system, WAPIC has been redesigned with necessary modifications. The inner cylinder has been introduced, which is mainly designed to prevent tar decomposition in the coil and to clean the chimney section easily in order to make the whole MICS more effective. To obtain pasteurisation temperature easily, space has been maintained between each number of turns so that the turbulent flow of water inside the coil would receive more heat energy from the source.

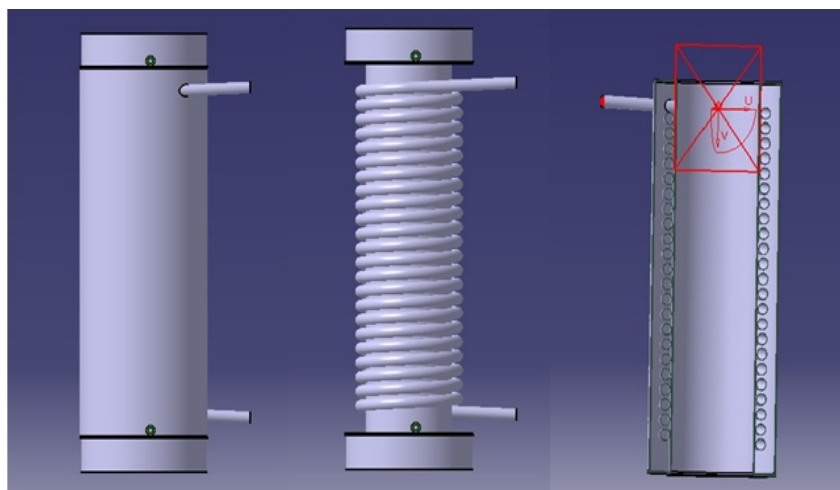


Figure 2: Computer design model of the WAPIC cylinder and coil for KU-3 MICS application.

Water Pasteurisation and Testing for Decontamination

It is well known that access to water and sanitation is a fundamental human right, and essential to life, health, hygiene and dignity. Timely and adequate provision of clean water and sanitation services to underprivileged people is particularly important, given their vulnerability. The UN believes each person should have access to adequate drinking water whether they stay in rural or in urban areas [6].

Several field tests were developed at the Sibiu Regional Public Health Laboratory in order to measure the water pasteurisation and decontamination. Tests were done according to ISO requirements and the results are presented below in Figure 3.

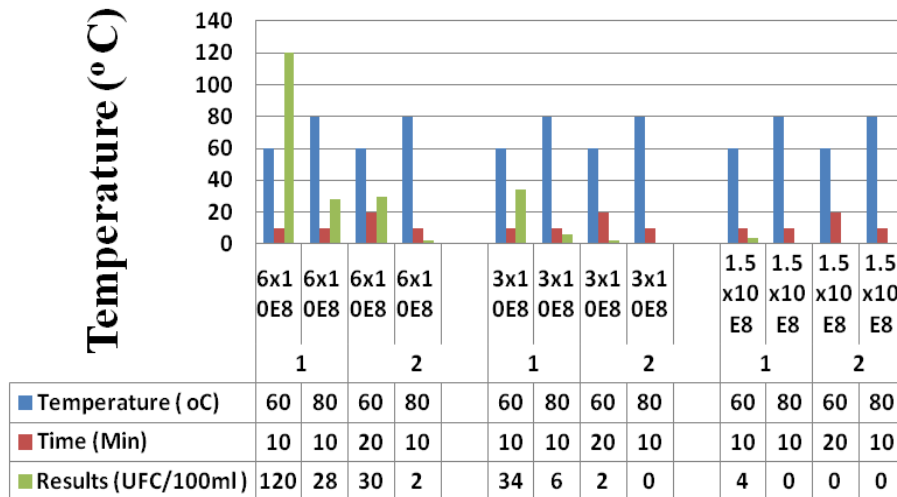


Figure 3: Inoculation test for E coli water decontamination after pasteurisation in a WAPIC cylinder.

Potability of water tests determined by laboratory analysis concluded that: from the results obtained from sample three, water having a concentration of 1.5×10^8 must undergo heat treatment for 10 minutes at 80°C to annihilate the *Escherichia coli* and from samples one and two, water having concentration 6×10^8 and 3×10^8 must undergo heat treatment at 80°C for at least 10 minutes to annihilate the *E. coli*.

CONCLUDING REMARKS

Several factors, such as dynamic changes in the world economies, concern for the global environment, expansion of international legal institutions and increased migration have combined to create significant multicultural and international challenges for education. Meeting these challenges requires new international knowledge and skills.

Further, this study helped to understand and develop sustainability issues and the impact of engineering solutions in a global and societal context. Through this work on the project, the important conclusion is that engineering practice need not always be motivated by profit, but humanitarian factors are also very important. Additional surveys also will be conducted for potential improvements.

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