

## Development of a Sensor to Detect Condensation of Super-Sonic Steam

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**Abstract.** This paper explains the development and functioning of AC driven electrodes based sensor which is used for the study of condensation phenomena of steam. Time for the AC signals starts form 20 msecond to 1 second. Data acquisition system is employed against each time interval and the output data is fed into EIDORS (a free software algorithm). Images show the clear boundaries between pure steam, its interface and water.

### Introduction

Steam's importance and it's usage in the present day industrial age is out of question due to myriad dimensions that it has like its use in the direct contact heat exchanger, chemical mixing equipment, steam jet driven injectors and in food processing industry etc. When steam is injected into the water , direct condensation takes place depending upon the design of injection, temperature of surrounding water and inlet mass flow rates and pressures. Many researchers make their contributions on this frontier of science and technology that includes those which explains; different condensation modes [1], temperature profiles around steam plume and its plume shapes [2], plume penetration length [3,4], hydrodynamics of steam jet [5], condensation regime diagrams that depends upon CFD analysis and temperature profiles [6], Sonic steam jets experimental studies [7] and experimental studies on over expanded steam jets [8]. However, most of the studies are mainly related to the supersonic steam temperature , plume shape and hydrodynamic studies and till now non of the study is being conducted on observing the interface width that in turn may provide the efficiency of our designed injection mechanism. In this regard a sensor is designed and developed, which is capable to observe the condensation in a slice of water within time period of 3 seconds at 50Hz frequency and control over ON/OFF times of the AC signals are delivered to the electrodes for getting an image.

### Electronic System

Electronic system for the sensor used for observing condensation phenomena is designed using AT89C51 micro controller, solid state switches Max 4665, key encoder MM74C922, and Decoders 74HC137. 16 Stainless steel electrodes are mounted circumferentially around a column and such arrangement is located at 3 places with total 48 electrodes being thus consumed for the purpose. The sensor thus developed is to capture the interface boundaries movement with constant and variable temperature around the Super-sonic steam plume in radial, vertical and circumferential directions. The block diagram of the system is shown in the Figure 1 and the arrangement of the electrodes mounted on the rig is shown in Figure 2.