CHAPTER 1

INTRODUCTION

1.1 PROJECT BACKGROUND

Abrasive Water Jet (AWJ) machining is a type of unconventional machining process. The abrasive water jet has been upgraded from Water-jet machining to Water-jet cutter. The idea of abrasive water-jet is began in 1935 by Elmo Smith when the idea to add an abrasive into the water for the use of liquid abrasive blasting. After that, Leslie Tirrell created a mix of high-pressure water and the abrasive which is used for the purpose of wet blasting. Lastly, Dr, Mohamed Hashish has changed and develops the modern of abrasive water-jet technology.

The working principle of abrasive water-jet (AWJ) is the mixture of water and abrasive in a mixing chamber to cutting the harder materials such as composite materials, stainless steel, ceramics, titanium alloys and etc. The abrasive particles are accelerated by the flow of water and then come out the nozzle with the stream. Types of abrasive that is generally used for abrasive water-jet (AWJ) machining are sand (SiO$_2$), glass beads, aluminium oxide, garnet, and silicon carbide. An abrasive water jet (AWJ) system is a device that uses high-pressure processing (200-500 MPa) of water to accelerate the abrasive particles erodes the target material. High pressure of water
is accelerated through fine orifices (0.24 to 0.40 mm diameter) to produce a highly flow velocity of the water. The circulation flow through the mixing chamber to create a partial vacuum by the venturi effect and entrains abrasive particles are mixed and accelerated in the high velocity water flow in the nozzle. Materials from foam to metal, stone and ceramics is capable to cut when the water, abrasive and air is mixed. Through manipulation of robot head to cuts and careful control of cutting parameters, excellent surface quality and accuracy in machining complex geometries can be achieved (Nanduri et al, 2002).

Figure 1.1: Diagram of high-performance abrasive water-jet cutting head

There are two kinds of nozzles commonly used for material removal average in abrasive water-jet (AWJ), tungsten carbide nozzles which have a useful life of 12 to 13 hours and sapphire nozzles have a useful life of 3hr (Saurabh Verma et al, 2014).

Nozzle wear can occur depending on the system parameters abrasive water-jet (AWJ) and nozzle geometry. Example system parameters that occur in nozzle are nozzle length, inlet angle, diameter of the nozzle, orifice diameter, and so forth. For the nozzle geometry parameters that affect the nozzle to become wear which are nozzle length, diameter, inlet cone angle of incoming and inlet cone depth (Nanduri et al, 2002).

The wear conditions in the nozzle are difficult to simulate. Although the material properties such as density, hardness and fracture toughness provide some indirect indicators of performance put on nozzle material, a more direct measure wear resistance is required. This wear will affect the efficiency of momentum transfer between water and abrasive and for the wear diameter also has an impact on particularly effect at the width of the cut for machining.

1.2 PROBLEM STATEMENT

The challenge of wear in abrasive water-jet (AWJ) is mainly focused on the system parameters and cost for the types of nozzle. Wear of the nozzle wall also can lead the jet turn into an incoherent, leading to increase in kerf width on the workpiece, surface quality deterioration and loss of precision cutting. The system parameters such as nozzle diameter, it is well known that keeping the ratio, Ro, the diameter of the nozzle with a diameter about 0.3-0.4 (all parameters remaining constant) would lead to mixing and optimum cutting conditions. The rate of increase in the diameter of the exit note here is in line with expectations. The mixing conditions result in the most effective distribution not only improves performance but also increases the wear of cutting nozzle. When the nozzle diameter increases, there is less resistance / interactions lead to a downward trend in the rate of weight loss nozzles.