CHAPTER 1

INTRODUCTION

1.1 BACKGROUND OF THE STUDY

Aluminium is the most abundant metal and the third most abundant element in the earth's crust (8.3% by weight); it is exceeded in abundance only by oxygen, O (45.5%) and silicon, Si (25.7%), and is approached only by iron, Fe (6.2%) and calcium, Ca (4.6%) (Greenwood & Earnshaw, 2012). The chief ore of aluminium is bauxite. Bauxite is typically a soft (Mohs Hardness: 1-3), white to grey to reddish-brown in colour with a pisolitic structure, clay-like material, earthy luster and a low specific gravity (i.e. 2.0-2.5). The reddish-brown colour of bauxite is due to the presence of iron minerals. Bauxite is a residual type of ore deposit that has been left on the land surface following intense weathering of aluminium-containing rocks and the removal by leaching of silica and other minerals in a wet tropical and subtropical climate (Patterson et al., 1986). As bauxite generally occurs within a few feet of the surface and found superficially in the earth's crust, open-cut methods of mining are usually used for its extraction. Much of this process is highly mechanized. Topsoil is removes and caprock blasted away. Front-end loaders are then used to fill trucks which take the bauxite to a crusher from where the crushed bauxite is transported to a refinery factory for process or a port for shipping out of the region (Meyer et al., 2002).

Bauxite is the ore which is the most commonly used for the production of alumina and aluminium. Therefore, bauxite is the world's main source of aluminium. Major commercial deposits are found in Australia, China, Brazil, Guyana, Ghana, Guinea, Hungary, India, Indonesia, Jamaica and Suriname (Brown et al., 2010; 2015). Bauxite may contain up to 55% aluminium oxide (Al_2O_3) (Beach et al., 2001).The

production of aluminium metal from bauxite ore involves two-stage process, firstly the refining of bauxite to alumina by a wet chemical caustic leach process, namely the Bayer process, and, secondly the electrolytic reduction of alumina to aluminum metal, as known as the Hall-Heroult process (Meyer, 2004). Hence, bauxite, as known as red mud is the waste by-product of the Bayer process to extract pure aluminium oxide from bauxite ores for aluminium metal's production.

Bauxite mining activities have sprung up in Malaysia since late of year 2014, notably in Pahang's state capital of Kuantan, and an area along the east coast facing the South China Sea. According to the Minerals and Geoscience Department, bauxite production in Malaysia more than quadrupled to 962,799 tonnes in 2014 from 208,770 tonnes in 2013. The bauxite mines have been shipping increasing amounts of bauxite for aluminium production to China, filling a gap created when Indonesia banned the ore exports in January 2014 to encourage value-added processing at home (Mineweb, 2015). Malaysia supplied 1.27 million tonnes of bauxite to China in the first nine months of year 2014, 12 times more than the 105,000 tonnes in the same period for year 2013 (Malaysia Kini, 2015a). Besides, in the first 11 months of 2015, Malaysia exported more than 20 million tonnes of bauxite to China, up nearly 700 per cent on the previous year of 2014 (The Straits Times, 2016).

Rapid industrial development has contributed greatly to economic growth but there has been significant cost in environmental degradation and increased public health risks. Unregulated and rampant mining of bauxite activities had spread to the Beserah area in Kuantan, Pahang and exacerbated by the large number of transport lorries carrying the red soil to Kuantan Port for exporting. In this cases, red dust for bauxite mines contaminating the villages when bauxite-laden lorries transport the mineral ore to the port (The Star, 2015b). The wind will blow the red dust everywhere and when it rains, the water washes the dust down the drain, that flow directly into the rivers and finally into the sea. Many rivers and beaches such as Sungai Balok, Pantai Balok, Pantai Batu Hitam, Sungai Pengorak and Pantai Pengorak near Kampung Selamat north of Kuantan have been reported seriously bauxite-contaminated and turning into deep dark-red hue from natural green water (The Star, 2015a). Dangerous traces of heavy metals like arsenic, beryllium, cadmium, chromium, lead, manganese, mercury, nickel,

naturally-occurring radioactive materials such as thorium and uranium besides high levels of aluminium have been detected in this river and sea (The Straits Times, 2015b). Bauxite contaminated water poses a dangerous alarm to marine life by, for instance, clogging the gills of fish and suffocating them.

Surface water besides drinking water contaminated by bauxite is recognized as a major public health in many parts of the world. About one third of the world's population lacks sufficient access to safe drinking water and sanitation to meet their basic needs as well as approximately 900 million people rely on unimproved drinking water supplies (WHO, 2011). Access to good quality and safe water, makes a tremendous difference to our quality of life. As we step into the twenty-first century, it is realized that the trend towards urbanization is posing ever-increasing challenges with respect to water supply. In recent years, to find out cost effective alternative for treating high bauxite contaminant from surface water, many researches have been carried out. Commonly, surface water is treated by using conventional water treatment method that involved coagulation, filtration and disinfections processes (Crittenden et al., 2012). These processes have resulted in a higher cost in both construction and chemical usages like alum and chlorine to control the pathogens in treating raw water for drinking purpose besides causing higher risk to human health (Hammer, 2012).

However, nowadays a more economic and cost-effective alternative water treatment method has been implemented, namely riverbank filtration (RBF). Riverbank filtration describes the process of extracting water from rivers using pumping well located in the adjacent alluvial aquifer whereby surface water is subjected to a combination of physical, chemical and biological processes such as filtration, dilution, sorption and biodegradation, which significantly improve the raw water quality, substituting conventional water treatment method (Jaramillo, 2012). RBF water treatment technology has been widely used in Europe and has been proven effectively improving the source water quality (Ray et al., 2003).

In this study, soil from Sungai Pengorak riverbank was considered and the effectiveness of riverbank soil in improving the water quality parameters and water quality standards of bauxite contaminated water from Sungai Pengorak was investigated