# CHAPTER V

# CONCLUSIONS

## 5.1 Conclusions

The present study was focused on production and application of film in adsorption and photocatalytic process for chromium (VI) removal from synthetic wastewater. The result found that $TiO_2$/chitosan films can efficiently remove chromium(VI) from the wastewater. The studied parameters including quantity of chitosan, titanium quantity which are the major factors that affect on film properties, adsorption and photocatalytic activities for chromium(VI) removal

### 5.1.1 Role of chitosan content on $TiO_2$/chitosan and chitosan film properties, adsorption and photocatalytic activities for chromium (VI) removal.

1) From synthesis XRD spectra, chitosan and $TiO_2$/chitosan films in different chitosan contents which prepared from this method had no change in identity of chitosan and $TiO_2$.

2) $TiO_2$ powder, $TiO_2$/chitosan and chitosan films in different chitosan contents were analyzed by Scanning Electron Microscope (SEM).Results of this study shown that chitosan film surface was flat and smooth. While $TiO_2$/chitosan film found that $TiO_2$ particles were non-uniform scattered into chitosan.

3) In comparison of $TiO_2$ powder, $TiO_2$/chitosan film and chitosan film that used for removed 100 mg/L chromium(VI) concentrated by adsorption process, it was found that $TiO_2$/chitosan film could remove chromium (VI) with efficiency as 38.35% - 53.22 % whereas chitosan film could remove with efficiency as 15.03 – 31.06% and $TiO_2$ powder

could remove at 0.84%. In absorption process, chromium removal efficiency of $TiO_2$/chitosan film was higher than chromium removal efficiency of chitosan film and $TiO_2$ powder. For $TiO_2$/chitosan film prepared in different chitosan contents (1, 1.5, 2 and 2.5% with 0.4% Ti) it was found that 2.5% chitisan with 0.4% Ti provided the highest efficiency (53.22 % ) for chromium (VI) removal.

4) The adsorption behavior of chromium(VI) onto all of $TiO_2$/chitosan film tends to be a monolayer adsorption as described by the Langmuir isotherm. The relationship between $Q_0$ which is the maximum adsorption at monolayer coverage and chitosan content which found that $Q_0$ was decreased with the increasing of chitosan content on $TiO_2$ chitosan film. On the other hand, the relationship between $b$ which is a measure of the energy of adsorption and chitosan content which found $b$ was increased with the increasing of chitosan content on $TiO_2$ chitosan film.

5) The photocatalytic reduction reactions of $TiO_2$/chitosan film indifferent chitosan contents could describe by pseudo-first order pattern. The photocatalyic reduction of 100 mg/L chromium(VI) concentration. Value of $k_{obs}$ obtained from $TiO_2$/chitosan film provided the higher than $k_{obs}$ from $TiO_2$ powder (0% chitosan, 0.4% Ti ), 0.0003 $min^{-1}$. While $k_{obs}$ of $TiO_2$/chitosan film from 2.5%chitosan with 0.4% Ti (0.0255 $min^{-1}$) was higher than $k_{obs}$ of $TiO_2$/chitosan films in other conditions.

### 5.1.2 Role of Ti content on $TiO_2$/chitosan and chitosan film properties, adsorption and photocatalytic activities for chromium (IV) removal.

1) From synthesis XRD spectra, chitosan and $TiO_2$/chitosan films in different Ti contents that prepared from this method had no change in identity of chitosan and $TiO_2$

2) $TiO_2$ powder, $TiO_2$/chitosan and chitosan films in different Ti contents were analyzed by Scanning Electron Microscope (SEM).Results of this study shown that chitosan

film surface was flat and smooth. While $TiO_2$/chitosan film found that $TiO_2$ particles were non-uniform scattered into chitosan.

3) In compassion of $TiO_2$ powder, $TiO_2$/chitosan film and chitosan film that used for removed 100 mg/L chromium(VI) concentrated by adsorption process, it was found that $TiO_2$/chitosan film (0.2, 0.4, 0.6 and 0.8% Ti with 1.5% chitosan) could remove chromium (VI) with efficiency as 29.01% - 64.05 % whereas $TiO_2$ powder(0.2, 0.4, 0.6 and 0.8% Ti without chitosan) could only remove as 0.33-2.38 % chitosan film could remove with efficiency as 18.64 %. In absorption process, chromium removal efficiency of $TiO_2$/chitosan film was higher than chromium removal efficiency of chitosan film and $TiO_2$ powder. For $TiO_2$/chitosan film was prepared in different chitosan contents (0.2, 0.4, 0.6 and 0.8% Ti with 1.5% chitosan), it was found that 0.8% Ti with 1.5% chitisan provided the highest efficiency (64.05 % ) for chromium (VI) removal.

4) The adsorption behavior of chromium(VI) onto all of $TiO_2$/chitosan film tends to be a monolayer adsorption as described by the Langmuir isotherm. The relationship between $Q_0$, $b$ and Ti content found that $Q_0$ and $b$ values were increased with the increasing of Ti content on $TiO_2$ chitosan film.

5) The photocatalytic reduction reactions of $TiO_2$/chitosan films indifferent Ti content could describe by pseudo-first order pattern. The photocatalyic reduction of 100mg/L concentration chromium(VI) concentration, the range of $k_{obs}$ obtained from $TiO_2$/chitosan film provided the higher (0.0245-0.0358 $min^{-1}$) than that from $TiO_2$ powder (0.0001-0.0007 $min^{-1}$). While $k_{obs}$ of $TiO_2$/chitosan film from 1.5%chitosan with 0.8% Ti (0.0358 $min^{-1}$) was higher than $k_{obs}$ of $TiO_2$/chitosan films in other conditions.

## 5.2 Recommendations

In application of $TiO_2$ /chitosan film in real situation, the condition for the film preparation should be carefully selected in order to product the film that is suitable for industrial process. The recommendation for further research were shown as follow.

1) There are other parameters which affect film properties and need to be investigated such as chitisan viscosity , temperature, titanium precursors, sovent and acidic solution.

2) The photoreactor for lab scale have to modified as the UV light can not provide enough intensity for chromium(VI) removal.

3) The photacatalytic removal of other pollutants, organics and inorganic species should be investigated as they also presented in real wastewater.