令和２年度第２次募集

新潟大学大学院自然科学研究科博士前期課程入学者選抜試験問題

外国人留学生特別入試

材料生産システム

素材生産科学（化学工学系）

B4

専門科目（化学工学）・日本語
Specialized Subject (Chemical Engineering) • Japanese

注意事項
General instructions

１　この問題冊子は，試験開始の合図があるまで開いてはならない。
Do not see the contents of these question sheets before the start of the examination is announced.

２　問題冊子は，表紙を含めて全部で５ページある。
There are five pages including this cover sheet.

３　問題はI～IVの４問である。これらすべてに解答すること。
There are four questions from I to IV. Answer all of these questions.

４　解答は，出題科目に対応する解答用紙に記入すること。別の問題の解答用紙に記入した場合は無効となる。
Write your answer on the designated answer sheet corresponding to each question. If you use a wrong answer sheet, no marks will be awarded to the question.

５　解答用紙の表だけで解答スペースが足りない場合は，その用紙の裏に続けて解答してよい。ただし，「(裏面に続く)」と解答用紙の表面の一番下に明記すること。
If you cannot complete the answer on the front side of an answer sheet, you may also use the back side of the answer sheet. When you use the back side, write "continued on the back" clearly at the bottom of the front side.

６　受験番号は，各解答用紙の指定された箇所に必ず記入すること。
Enter your examinee number in the designated blanks of all answer sheets.

７　解答時間は，１２０分である。
The duration of examination is 120 minutes.

８　下書きは，問題冊子の余白を使用すること。
Use the margin of the question sheet for making a draft if necessary.

９　辞書や電子機器類の使用は認められない。
Using any dictionary or electric device is prohibited.

［I］ Summarize the following sentences, cited from an article on biodiesel, into about 150 words in English.

Biodiesel has received much attention as an alternative to petroleum-based diesel fuels. Fatty acid methyl esters (FAMEs) are the main component of biodiesel, and are derived from plant oils, animal fats, or waste cooking oils via esterification with methanol. Biodiesel must conform to the fuel properties stated in the standards in each country. A major disadvantage of biodiesel is poor flow at low temperatures, a direct consequence of the high melting points of saturated FAMEs. This property can lead to operating problems, such as the plugging of engine filters during cold weather.

If saturated FAMEs could be easily removed from biodiesel, the low temperature flow properties of the fuel would improve dramatically. One means of doing so is to separate saturated FAMEs through winterization. In this method, the FAME mixture is cooled so that a saturated FAME-rich solid phase forms. Ideally, the unsaturated FAME-rich liquid phase is then separated from the saturated FAME-rich solid phase, and this unsaturated material will exhibit higher fluidity at low temperatures, even though the saturated FAME-rich solid phase typically has a higher cetane number and greater oxidative stability, both of which are important in a diesel fuel. In practice, the recovery of the liquid phase is typically very low and solid–liquid phase separation and associated compositional changes in the liquid phase are not observed because the unsaturated FAMEs can be trapped in crystals of the saturated FAMEs.

To prevent this type of inclusion, mechanical agitation is typically applied during winterization. Another means of improving the winterization yield is using chemical additives acting as cold flow improvers that prevent crystal growth and modify crystallization behavior. Winterization with cold flow improvers can potentially be used to inhibit the crystallization of saturated FAMEs and thus would assist in overcoming low temperature flow.

Traditional winterization requires several mechanical operation stages, such as agitation and filtration, for saturated FAME removal. In addition, traditional winterization has poor separation efficiency of saturated FAME in single step. Because these additional and multiple processes increase the overall energy requirements, equipment costs and material losses, it would be beneficial to simplify the previous winterization process.
(351 words)

[Modified from M. Abe et al., "Effect of nonionic surfactants on the low temperature winterization separation of fatty acid methyl ester mixtures," Fuel 190 (2017) 351-358]

［Ⅱ］ Explain the following terms briefly.

(1) density of a substance

(2) viscosity of a fluid

(3) laminar flow and turbulent flow

(4) the First law of thermodynamics

［Ⅲ］ Answer the following questions (1) to (4).

Michaelis-Menten type enzymatic reaction scheme is written by Eq. (a).

$$\mathrm{E} + \mathrm{S} \underset{k_2}{\overset{k_1}{\rightleftharpoons}} \mathrm{ES} \xrightarrow{k_3} \mathrm{E} + \mathrm{P} \qquad \text{Eq.(a)}$$

where E = enzyme, S = substrate, ES = enzyme-substrate complex, P = product, k_i (i=1~3) = rate constant of reaction shown with the arrows in Eq. (a). The concentration of substrate, free enzyme, enzyme-substrate complex, and products are expressed as [S], [E], [ES], and [P], respectively.

(1) Write the rate equation for the substrate, d[S]/dt.

(2) Write the rate equation for the enzyme-substrate complex, d[ES]/dt.

(3) Write the rate equation for the product, d[P]/dt.

(4) Derive the Michaelis-Menten equation under the steady-state approximation. Also, assume that total enzyme concentration [E_0] is constant and is equal to [E]+[ES].

Michaelis-Menten equation: $r = k_3[E_0][S] / (K_m + [S])$

where K_m = Michaelis constant, $(k_2 + k_3) / k_1$.

［Ⅳ］Answer the following questions (1) and (2).

(1) Translate the following words into English.

① はる（春）

② ゆき（雪）

③ みず（水）

④ やま（山）

(2) 次の 文章と 同じ意味の 英語の文を 選び 解答用紙に 記入しなさい。

① わたしは たまねぎを ３個 買いました。

（あ）I don't buy three onions.

（い）I bought three onions.

（う）I will buy three onions.

② いま 雨が 降って いますか。

（え）It is raining now.

（お）It is not raining now.

（か）Is it raining now?