Unit Operations for Process Engineers

Unit operations are the essential steps in any industrial process that involve physical or chemical changes in matter. The word “unit” means that these operations can be combined in different ways to create the overall process. They are important for designing, analyzing, and optimizing industrial processes, as well as for understanding the basic principles and phenomena that regulate them. Process engineers, especially chemical and environmental engineers, need to learn the concepts and applications of various unit operations, Some of the most common and useful unit operations in the industry are:

1) **Distillation:** This unit operation is used to separate a mixture of two or more substances based on their boiling points. It is widely used in the petroleum, petrochemical, pharmaceutical, and food industries, as well as in environmental engineering and water treatment.

The results of distillation are called distillate and residue,

- **Distillate** is the liquid or vapor phase that contains the more volatile component.
- **Residue** is the liquid or solid phase that contains the less volatile component

2) **Liquid-liquid extraction:** This is a type of extraction that involves two immiscible liquid phases, usually water and an organic solvent. The solute is transferred from one phase to the other based on its relative solubility and distribution coefficient. It is used to remove impurities, recover valuable compounds, or separate organic or metal solutes

The results of extraction are called extract and raffinate,

- **Extract** is the liquid phase that contains the desired component or solute
- **Raffinate** is the liquid phase that is depleted of the solute.

3) **Solid-Liquid Extraction (Lixiviation):** This is a type of extraction that involves a solid phase and a liquid solvent. The solute is dissolved from the solid into the liquid by contacting them in a suitable vessel or tank.

   The resulting solution is called a **leachate** and the remaining solid is called a **residue**.

   Lixiviation is often used to extract metals from ores, minerals, or wastes, using water or acidic solutions as solvents.

4) **Adsorption:** This unit operation is used to separate a mixture of two or more substances based on their affinity to a solid surface. It is used to remove pollutants, dehydrate gases, capture carbon dioxide, or separate paraffins and aromatics.

   Some of the most known adsorbents are **activated carbon**, **zeolites**, and **silica gel**.

5) **Absorption:** This unit operation is used to transfer a gas or vapor component from a gas mixture into a liquid phase. The liquid acts as a solvent or absorbent that dissolves or captures the gas component. Absorption is used to purify, recover, or remove gas components from gas streams, such as ammonia, hydrogen sulfide, carbon dioxide, or volatile organic compounds.

6) **Humidification:** This unit operation is used to increase the moisture content or humidity of a gas stream by adding water vapor or liquid droplets. Humidification is often required for various reasons, such as providing optimal conditions for certain chemical reactions, maintaining specific humidity levels in controlled environments, and improving the efficiency of certain industrial processes.

7) **Drying:** This unit operation is used to decrease the moisture content or humidity of a solid material or a liquid mixture by removing water or another solvent. Drying is often used to stabilize, conserve, or improve the quality and handling of the material or mixture, as well as to reduce the cost of transportation and storage.

English Vocabulary	French translation	Arabic translation
unit operation	opération unitaire	عمليات الوحدة
industrial process	procédé industriel	عملية صناعية
physical or chemical change	changement physique ou chimique	تغيير فيزيائي أو كيميائي
matter	matière	مادة
design	concevoir	تصميم
analyze	analyser	تحليل
optimize	optimiser	تحسين
principle	principe	مبدأ
phenomenon	phénomène	ظاهرة
concept	concept	مفهوم

application	application	تطبيق
gas	gaz	غاز
vapor	vapeur	بخار
liquid	liquide	سائل
solid	solide	صلب
phase	phase	مرحلة
detach	détacher	فصل
extract	extraire	استخراج
heat	chaleur	حرارة
light	lumière	ضوء
electric energy	énergie électrique	طاقة كهربائية
pressure	pression	ضغط
composition	composition	تكوين
system	système	نظام
absorption	absorption	امتصاص
adsorption	adsorption	امتزاز
regenerate	régénérer	تجديد
recover	récupérer	استعادة
humidification	humidification	ترطيب
moisture content	teneur en humidité	محتوى الرطوبة
humidity	humidité	رطوبة

water vapor	vapeur d'eau	بخار الماء
liquid droplet	gouttelette de liquide	قطرة سائلة
reason	raison	سبب
controlled environment	environnement contrôlé	بيئة مضبوطة
efficiency	efficacité	كفاءة
drying	séchage	تجفيف
solvent	solvant	مذيب
stabilize	stabiliser	تثبيت
conserve	conserver	حفظ
handling	manipulation	معالجة
cost	coût	تكلفة
transportation	transport	نقل
storage	stockage	تخزين