

Particle Size Separation

Dr. Isra Dmour

Credit: Prof. Nizar Al-Zoubi

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فصل حسب الحجم

Particle Size Separation

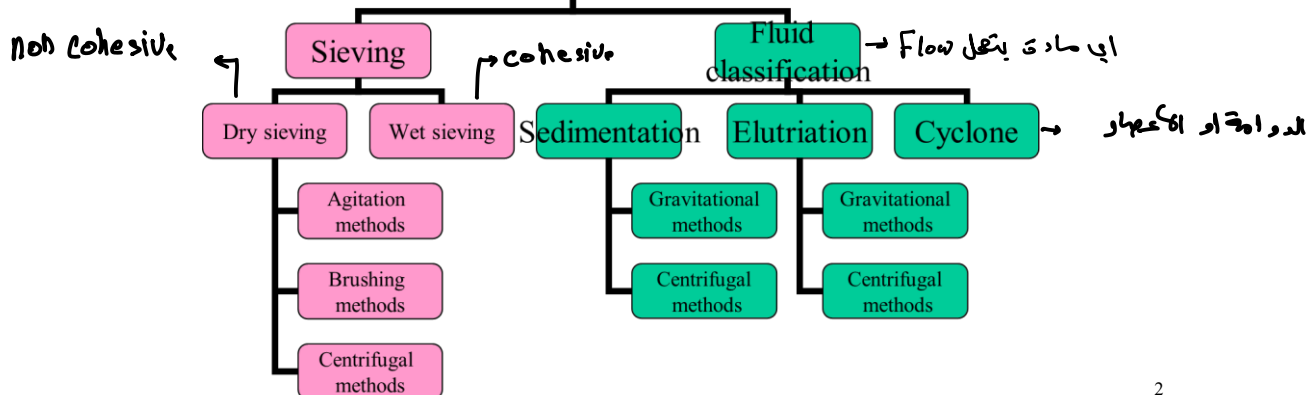
It is the classification of powder into separate particle size ranges.

Solid separation is the removal (separation) of powder particles from gases or liquids.

فصل الصلب من الغاز والسائل

Particle Size Separation

كيف نفصل الجسيمات



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Sieves في separation يكون اكبر

Size-Separation Methods

في طرق separation sieve يكون عن طريق
الاستخدام في analysis ؟

Size separation by sieving عبيدة

❖ Principle of operation is similar to the use of sieving in particle size analysis with the following differences:

- Sieves should be resistant to chemical action with the material to be sifted (It is more suitable to use stainless steel sieves than brass or bronze sieves).
- The amount of material is larger in case of particle size separation than in particles size analysis, and therefore:
 - requires larger sieves
 - there are several techniques to encourage the particles to separate into their appropriate size fractions.
- Size separation can be done by dry or wet sieving.

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Size-Separation Methods

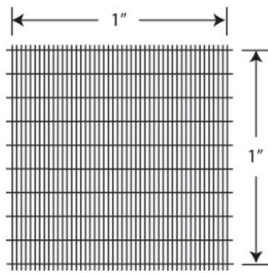
Size separation by sieving

- Sieves are described by :

- Opening size
- Number of opening per linear inch (mesh number)

حجم الفتحة

عدد الفتحات بالانص
كل ما زاد Mesh زادت عدد الفتحات
Fine particles



48x10 Mesh



Table 3 Openings of Standard Sieves, U.S. Series

Assigned number	Sieve opening
2	9.5 mm
3.5	5.6 mm
4	4.75 mm
8	2.36 mm
10	2.00 mm
14	1.40 mm
16	1.18 mm
18	1.00 mm
20	850 μm
25	710 μm
30	600 μm
35	500 μm
40	425 μm
45	355 μm
50	300 μm
60	250 μm
70	212 μm
80	180 μm
100	150 μm
120	125 μm
200	75 μm
230	63 μm
270	53 μm
325	45 μm
400	38 μm

بمقياس
الفتحة

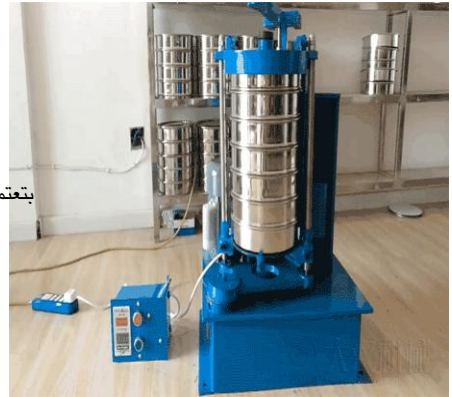
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Dry sieving techniques

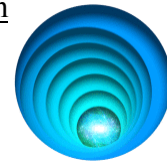
1. Agitation methods:

- In these methods size separation is induced by vibrations which facilitate passing of particle through pores. بتعتمد على اهتزاز او حركة دورانية لتسهيل مرور الحبيبات عبر الفتحة.
- Alternatively, by suitable way gyration of sieves can be used which causes the particles to spin, and thereby changing continuously their orientation. تدوير دورات
- The output from gyratory sieves is often greater than that obtained by vibration sieving.

النتائج من دورات (gyration)
أكثر من نتائج الاهتزاز (vibration)



gyration



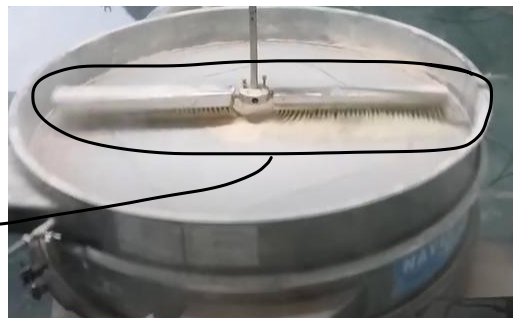
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Dry sieving techniques

2. Brushing methods:

الطريقة الأقدم

- A brush is used (manually on small scale and mechanically on large scale) to reorientate particles on the surface of a sieve and prevent blocking of pores.



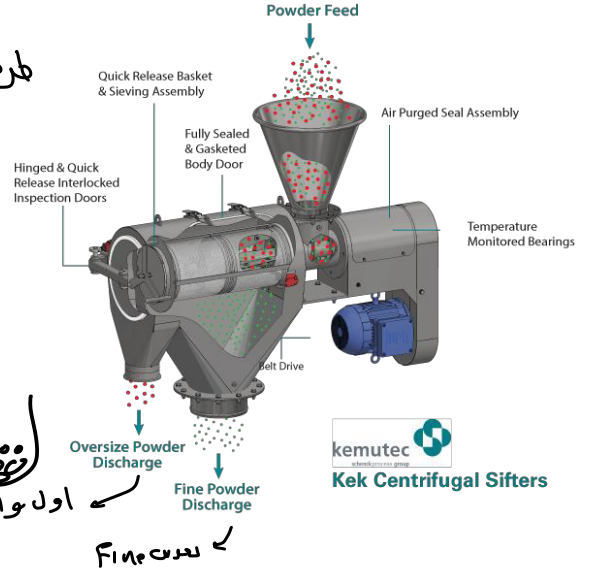
brush نوعية معينة ←

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Dry sieving techniques

3. Centrifugal methods: طرد مركزي

- Particles are thrown outwards onto a vertical cylindrical sieve under the action of high-speed rotor inside the cylinder.
- The current of air created by the rotor also assists in sieving.



الجسيمات بتترمى نحو الخارج على سطح منخل
اسطوانى عمودي بواسطة روتور عالي السرعة داخل
الأسطوانة

حركة الهواء الناتجة عن rotor بتساعد كمان بالغريبة

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Wet sieving → فصل المحر من dry

- Wet sieving is generally more efficient than dry sieving.



لانه السائل بغير تجميع الجزيئات وبتجمع
Block واسرع لانه السائل بيسمج الجزيئات
صه .

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بعمل ترسيب من خلال وضع الجزيئات في سائل وبعد وقت المواد الكبير (الاثقل) رح يترسبوا والصغار رح يضلوا فالسطح فأنا بجيب pipette او pump ويسحب الصغار فبعمل separation مكون من جزيئات صغار بس



Size separation by fluid classification

Sedimentation methods → gravity الوحيدة هي force

- Principles of operation

Gravitational methods

- Simple forms of sedimentation classification uses a chamber containing a suspension of solid particles in a liquid.
- After predetermined time , particles less than a given diameter can be recovered by a pipette placed at a fixed distance below the liquid surface, or alternatively by a pump.

Alternative technique

- Continuous settling chamber: Particles in suspension enter a shallow container and they are acted by a driving force divided into two components:
 1. horizontal due to particle velocity and
 2. vertical due to gravity and corresponds to Stoke's settling velocity.
- The coarsest particles will sediment closest to the inlet, whereas the finest particles will sediment furthest from the inlet.

جوزن وفتح

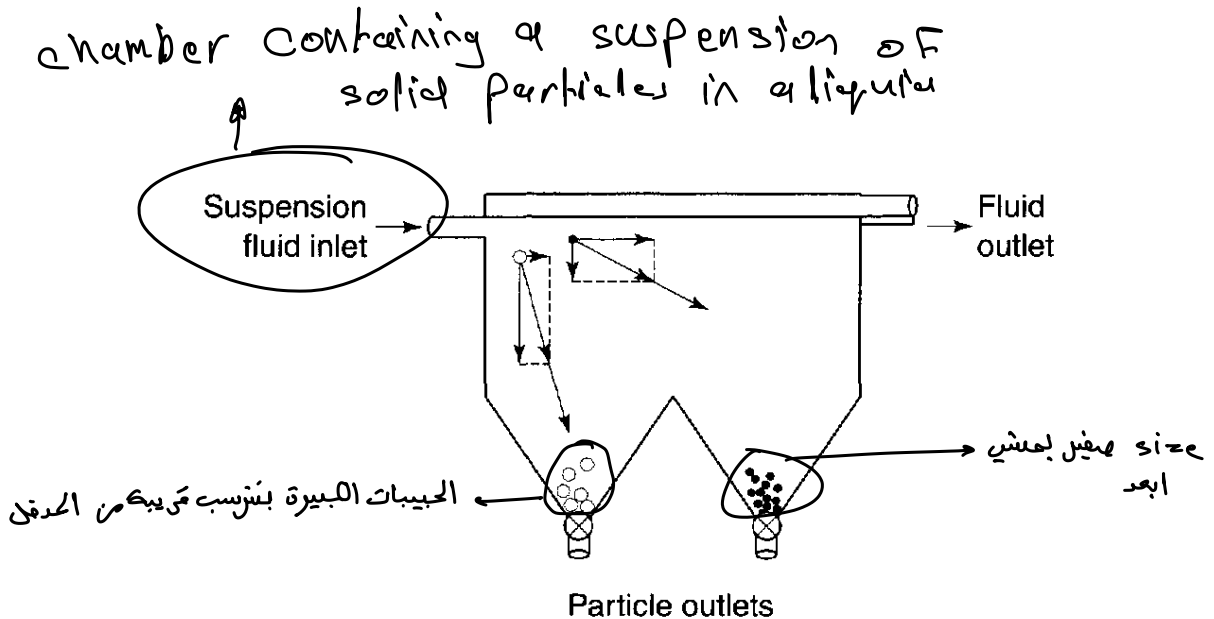


Fig. 12.4 Continuous settling chamber showing vectors of particle movement for different sizes.

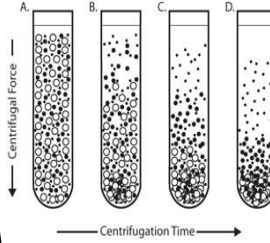
< 8 Mm Size separation by fluid classification

- Very fine particles will not sediment efficiently under the influence of gravity due to Brownian diffusion. الحبيبات الصغيرة جداً ما بتترسب منيح بالجاذبية لوحدها بسبب Brownian diffusion
- In order to increase the driving force of sedimentation, centrifugal methods can be used. للتعامل من الحبيبات الصغيرة بنستخدم الطرد المركزي لتزويد القوة الدافعة وترسيبها بشكل فعال.



Centrifugal methods

- Single cylindrical centrifuges can be used to remove single size cuts from a fluid stream.
- Multiple chamber centrifuges can separate a number of size ranges.



يمكن تفصل عدة فئات حجمية بوقت واحد

تفصل قطع حجم واحدة من التيار

نفس مبدأ sedimentation بس السرعة

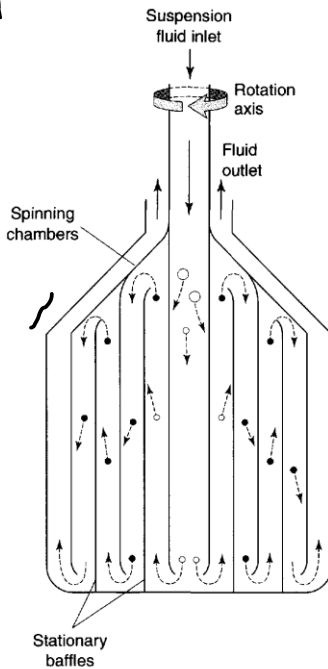
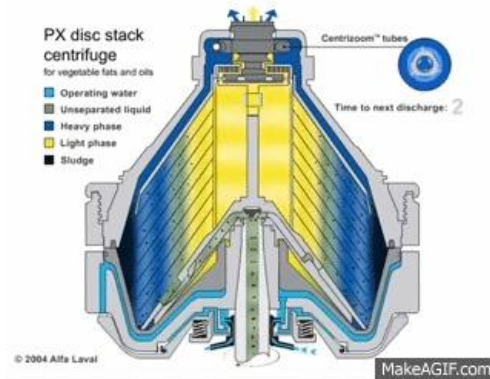


Fig. 12.5 Multiple-chamber separation centrifuge.



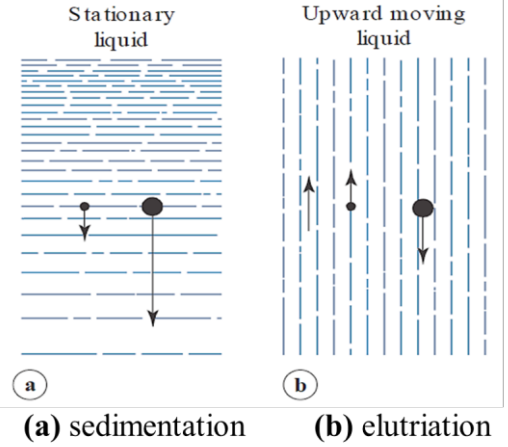
الجزئيات الكبار رح يطلعوا ويرجعوا ينزلوا بسبب وزنهم الكبير ،اما الصغار رح يتأثروا بضخ السائل من تأثرهم بالجاذبية لانه وزنهم قليل.

Size separation by fluid classification

السائل يتدفق بعكس اتجاه تريب الجسيمات

Elutriation methods

- Elutriation is a technique in which the fluids flows in an opposite direction to the sedimentation movement.
- Particles are divided into different size fractions depending on the velocity of the fluid.



الجسيمات بتتقسم حسب سرعة السائل:

إذا سرعة السائل اكبر من سرعة ترسيب حبة معينة ،الحبة بتبقى مع التيار تصعد وإذا اقل بتترسب.

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Size separation by fluid classification

Elutriation methods

- The simple way is the separation of particles when they are suspended in a fluid moving up a column. عمود فيه تيار صاعد قوة الضخ ما بتكون متساوية في كل tube (بالص ضخ اقوى)
- In practice , the fluid velocity in a tube is not uniform.
- The highest velocity is found in the center and the lowest velocity at the tube walls. الاقل سرعة تكون على الجوانب الاكبر سرعة تكون في المنتصف
- Particles can be seen to rise with the fluid and then to move outwards to the tube wall, where the velocity is lower and then tend to fall down.
- A separation into two sizes occur, but the size cut will not be clearly defined. رح يفصل الاحجام بس طارح اقترانه

الحبيبات بتصعد وبعدين تتجه للخارج للجدار وينقص السرعة فتقع .

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جهاز يستخدم الهواء يحتوي على شبكة بتسمح بمرور المواد الصغيرة

فيمكن يكون له gas او $liquid$ (air)

Size separation by fluid classification

Elutriation methods

شبكة داعمة بتحمل الجسيمات ،والهواء بمشي من تحت الشبكة.

Upward airflow elutriator

شبكة

- Particles are held on a supporting mesh through which air is drawn.
- Classification occurs within a very short distance of the mesh.
- Any particles remaining entrained in the air stream are accelerated to a collecting chamber by passage through a conical section.

بتنقل الجزيئات الصغيرة لا غرقة لجميع
بعد عبور المخروط



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دiameter فتلت

المغارة الوسطى ينتقلوا الى جهة

Size separation by fluid classification

في على ما كان القطر افلا يكون الفواحم

Multistage elutriators

These are gravitational elutriator used to separated powders into several size fractions. It is composed of columns with increasing diameters.

As the diameter increase the fluid velocity decrease and smaller particles can be separated.

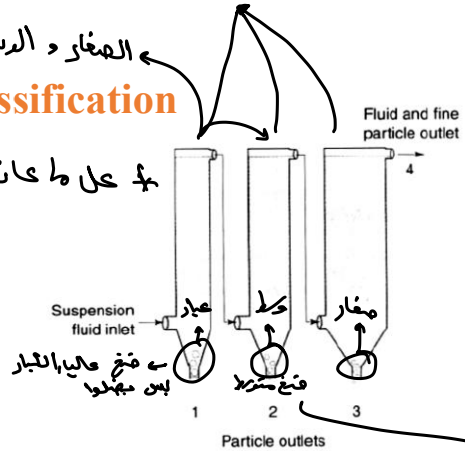


Fig. 12.9 Multistage elutriator. Particle outlets 1 to 4 collect fractions of decreasing particle size.

2 3 يجمع بين
الوسط
في المغارة ينتقلوا الى جهة



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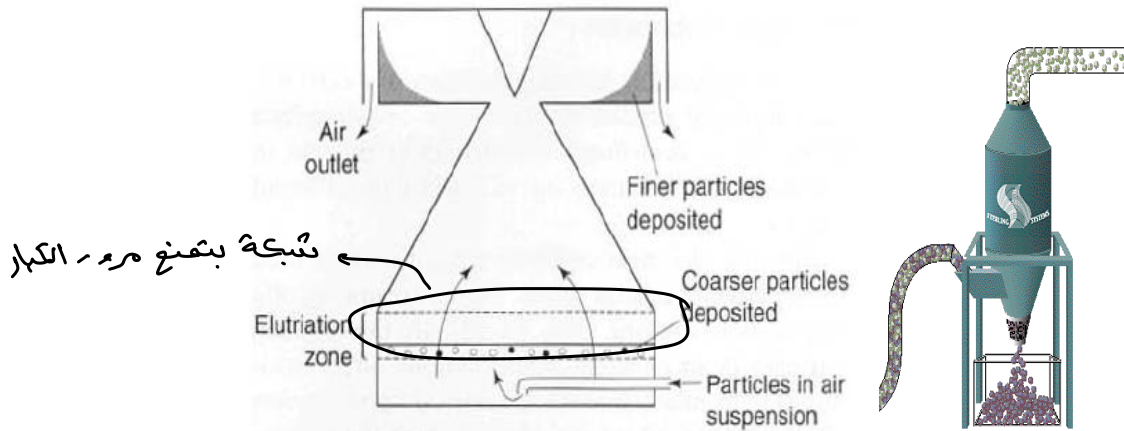


Fig. 12.10 Upward airflow elutriator.

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تيار يدخل بشكل مماسي للجزء الاسطواناني من السيلكون بخلق دوامة، القوة الطردية تدفع الجسيمات للجدار وتنزل تحت.

Size separation by fluid classification

Cyclone methods

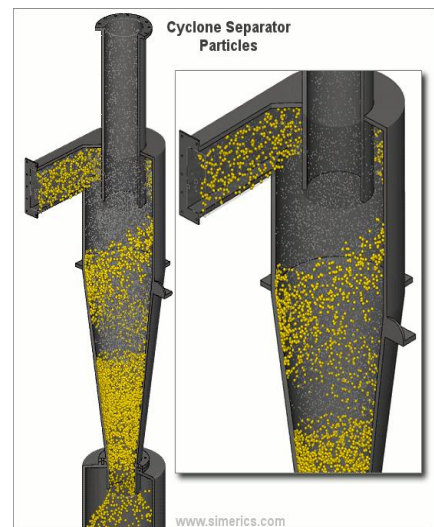
Principle of operation:

- The most common type of cyclone used to separate particles from fluid stream is the reverse-flow cyclone. الاعصار العكسي

- In this system, Particles in air or liquid suspension are introduced tangentially into the cylindrical upper section of the cyclone.

- The relatively high fluid velocity produces vortex that throws solid particles out onto the walls of the cyclone. دوامة

بدخل الجزيئات من فوق بالعرض عشان
بتكون اعصار (طريقة مماسية)



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Size separation by fluid classification

Cyclone methods

الجزيئات ينزلوا ويرجعوا بطلعوا بسبب flow

- The particles are forced down the conical section under the influence of the fluid flow.
- At the tip of the conical section the vortex of fluid is above the critical velocity at which it can escape through the narrow outlet and form an inner vortex which travels back up the cyclone.
- Coarser particles separate from fluid and fall out on the cyclone, while finer particles leave with the fluid through the vortex finder.

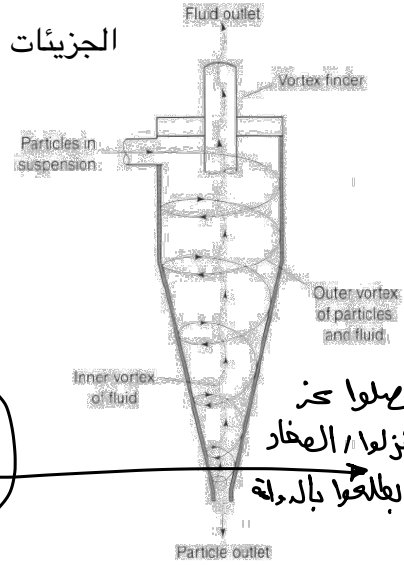


Fig. 12.12 Reverse-flow cyclone separation.

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لما يوصل للجزء الضيق بالمخروط بترجع الجزيئات بتطلع من خلال دوامة بس flow عالي

Method	Separation range
Sieving	Available range $\approx 5 - 125\,000\ \mu\text{m}$ Pharmacopoeial range $\approx 38 - 9500\ \mu\text{m}$
Gravitational sedimentation	$\approx 5 - 1000\ \mu\text{m}$
Centrifugal sedimentation	$\approx 0.1 - 5\ \mu\text{m}$ مفار
Gravitational elutriation	$10 - 500\ \mu\text{m}$
Centrifugal elutriation	$0.5 - 50\ \mu\text{m}$ مفار
Cyclone	$5 - 150\ \mu\text{m}$

اللهم وفّقني في امتحاني، وامنحني صفاء الذهن، وسكينة القلب، وثبات الحفظ.
اللهم سهّل عليّ كل صعب، وذكّرني ما نسيت، وافتح عليّ فتوح العارفين.
اللهم اجعل جهدي وتعبني ثمرة نجاح وفخر، ووفّقني لما تحب وترضى ♥

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