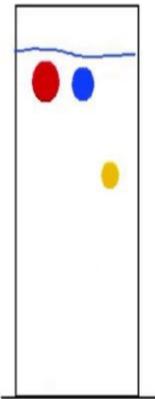


Sedimentation (settling properties):



- Sedimentation means settling of particle or floccules that occur under gravitational force in liquid dosage form.

Stoke's equation:

14

* الی حجمه اکر بنزی اول
تحت تاثیر الجاذبیه ..

توسیب کونفا (loose)؟
* وجود لا liquid ..

(تجمع من الرواقل particles)

مجموعه صغیرة من المواد
Small (loose) aggregated
bit of Material suspended
from Liquid.

تأ اقل Shaking سهل یجل redispersion ← floccules ..

14

How to control the settling properties?

- The **rate of sedimentation** of a suspended phase depends on several factors which may be controlled by pharmaceutical manipulation.
- Assuming that all dispersed particles are of **uniform shape and size** and that the particles are sufficiently **far apart** so that the movement of one **does not** affect the neighboring particles, the rate of sedimentation can be estimated **by Stoke's equation:**

$$V = \frac{d^2 (\rho_1 - \rho_2) g}{18 \eta_0}$$

- where **V** is the sedimentation rate (cm/sec),
- d** the **diameter** of the **suspended particles** (cm),
- ρ_1 its density and ρ_2 is the density of the medium (g/cm^3),
- g** is the **acceleration of gravity** (980.7 cm/sec^2) and ≈ 10
- η_0 is the **viscosity of the external phase** in poises (g/cm sec).

* علاقة مكيبة ..

ما بصحني ال Density
للمادة ولا ال Density
للوفا .. الي بصحني الفرق
بينكم !!

to be Suspended..

15

ال factors الي
بتحكم فيهم عثمان افصح
التقول الريح ..

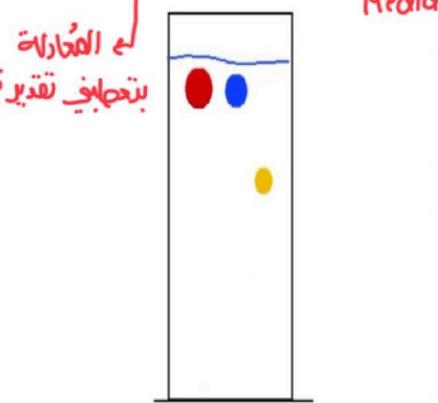
How to control the settling properties?

- Stokes' equation gives an approximation of the settling rate and an appreciation of the variables governing the sedimentation process

$$V = \frac{d^2 (\rho_1 - \rho_2) g}{18 \eta_0}$$

- For example, by reducing the particle size or by increasing the viscosity and density of the external phase, the rate of sedimentation can be retarded.

وهو اعز هو اننا ال External
عثمان يصير الفرق بينكم اقل



للمقارنة
بتصايف تقدير تقريبي

Media

16

موجود بالسلايين
اللي بعد ..

* بالحجم ..
علاقة طردية
كل ما زاد ال particles
تزيد Sedimentation

" بس مو كل حجم صغير
يخفي مقبول !! "

لياصليب ؟:

لأن تما يكون الحجم كبير صغير زي
مطبوخة مع يزيد ال Surface Area

بالتالي مع تزيد ال Surface Energy

كل شي موجود مصنوع تكون عايشة

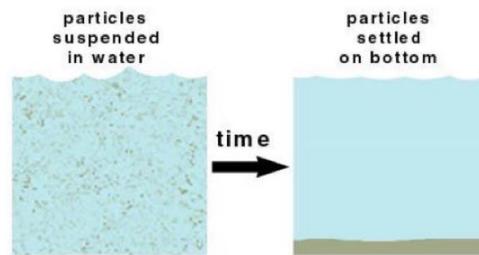
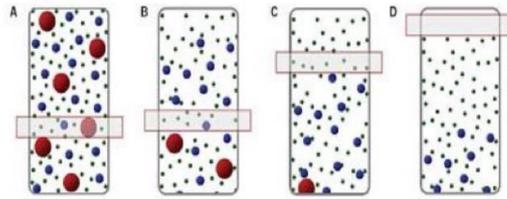
ساعة غير ممتعة بالتالي ال particles

مع تزيد تفتح عثمان تزيد ال Surface Area

16 (Aggregation) ويتولد حجم كبير

How to control the settling properties?

1. By reducing the particle size of the dispersed phase produces a slower rate of sedimentation of the particles. The velocity of fall of a suspended particle is greater for larger particles than it is for smaller particles.



التي بالتمام
كحي + ρ₂

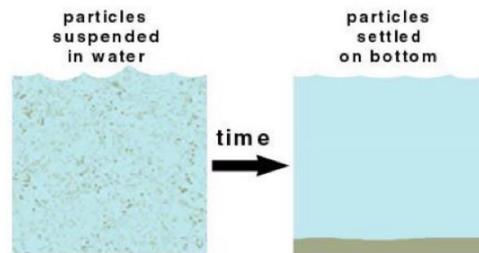
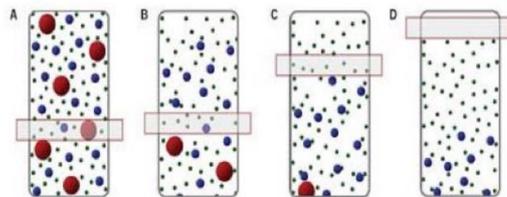
$$v = \frac{d^2(\rho_1 - \rho_2)g}{18\eta_0}$$

17

17

How to control the settling properties?

• However, one should avoid reducing the particle size too much, because fine particles have a tendency to form a compact cake upon settling to the bottom of the container. The result may be that the cake resists breakup with shaking and forms rigid aggregates of particles that are larger and less suspendable.



برضاة قبل ما حكيته قبل
عشان ماتزول ال
Surface Area
وزداد ال Surface Energy
ويكبر

بتقاوم التفتك مع
الاهتزاز ويتجمع بالقاع.
فهاد شي هو لازم يصير.

$$v = \frac{d^2(\rho_1 - \rho_2)g}{18\eta_0}$$

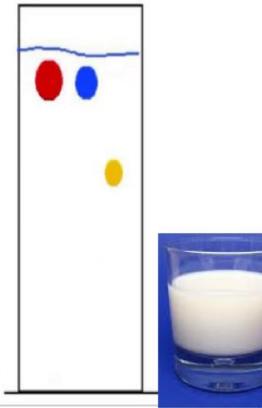
18

18

How to control the settling properties?

2. Also, the greater the density of the particles, the greater the rate of sedimentation, provided the density of the vehicle is not altered.

$$V = \frac{d^2(\rho_1 - \rho_2)g}{18\eta_0}$$



- Because aqueous vehicles are used in pharmaceutical oral suspensions, the density of the particles is generally greater than that of the vehicle, which is a desirable feature.
- If the particles were less dense than the vehicle, they would tend to float and floating particles would be quite difficult to distribute uniformly in the vehicle.

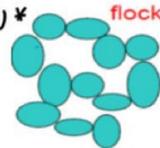
إذا كان Density لل particles لازم تكون أعلى من ال Density الوسط مثلاً إذا أتد مع تصاف وما تقبل لتزل .. وعلاية توصيهم عنان أشرب المواد لا يكون صعب ..

19

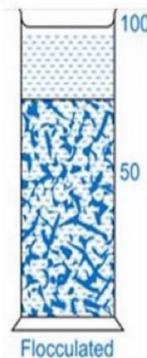
How to control the settling properties?

3. Flocculating agents

- flocculation refers to process which leads to aggregates that are loose or open
- Flocculating agents are electrolytes that carry an electrical charge opposite from that of the net charge on the suspended particles
- Electrolytes act as flocculating agents, apparently by reducing the electrical barrier between the particles of the suspensoid and forming a bridge so as to link them together.
- The addition of the flocculating agent, at some critical concentration, reduce the surface charge on the suspended particles and allows the formation of floccules or clusters.
- Floccules will not cake and may be easily redispersed by shaking the suspension.



→ reducing the surface charge of suspended particles or bridging between particles.



20

الفطوق العاكيلول ما يكون cake ، dispersid ، سهل ال Shaking تريح الجزينات من cake أو -

القوكيز اللى بيفتح مقبول هو .. Ver

20

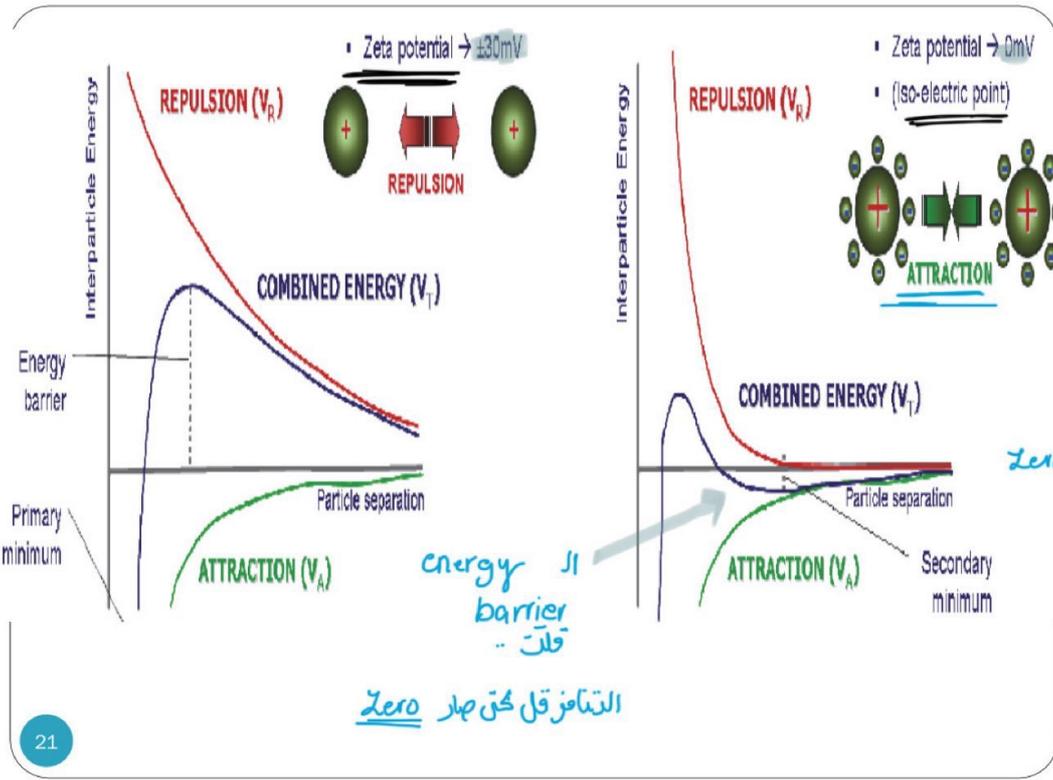
بغير ال Density لا particles ..
بش شرط ما أيز ال Media ..

Aqueous vehicles
هو الشافغ فال Density
بتكون larger

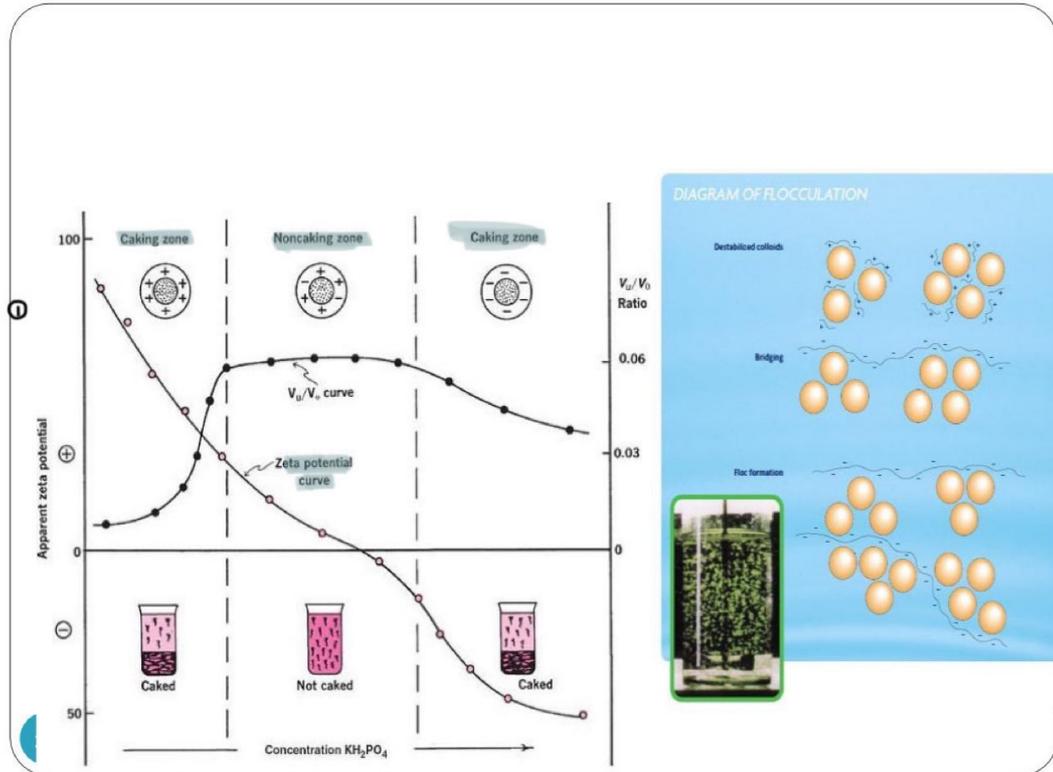
لشوايب اللى بجاي

ال particles ما تلصق ببعضها
وجود charge على ال particles :

لما تزل بتقل ال Repulsion
بكوني (فلايول) جعل Linking as bridge ..



21



	Flocculated	Deflocculated
Sedimented particle	Forms a network like structure	Separate individual particles
Velocity of sedimentation	fast fall together	Slow fall according to size
Boundary	a distinct boundary between sediment and supernatant	no distinct boundary between sediment and supernatant
Supernatant	clear	turbid
Suspension	Not pleasing in appearance	Pleasing in appearance
Viscosity	High	Low
Rheology	Plastic & pseudoplastic	Dilatant, Newtonian
Sediment	Loosely packed and doesn't form a cake	Closely packed and form a hard cake
Redispersibility	Easy	Difficult

في صه نجيل ما بين
Sediment - Supernatant



the liquid above the solid.

و اعادة التشتت

25

* تأثير الـ viscosity عكسي ، غالباً مواد بتدعي "thickness" ←

← بتدعي الـ particles تتوقف بل ما تزل ← reduce the movement of particles

↓
Stabilization

How to control settling properties:

4. Viscosity enhancers (suspending agents or thickening agents)

- flocculation as a means of preventing caking will increase the particle diameter, and thus increase the rate of sedimentation.
- Now we need some means to reduce this rate of settling, so that the suspension can be accurately dosed before it begins to settle.
- Practically speaking, the viscosity of the dispersion medium is the only other Stoke's variable affecting sedimentation rate over which the pharmacist can exert any control.

$$V = \frac{d^2(\rho_1 - \rho_2)g}{18\eta_0}$$

26

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- Suspending or thickening agents are added to suspensions to thicken the suspending medium, thereby reducing the movement (sedimentation) of suspended particles and physically stabilizing the product.
- This is particularly important in flocculated systems in which rapid particle settling is the primary factor leading to physical instability and lack of dosage uniformity in the product.



$$V = \frac{d^2 (\rho_1 - \rho_2) g}{18 \eta_0}$$

27

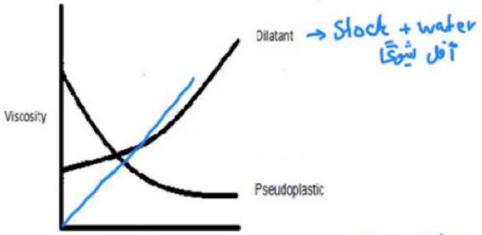
27

* بسن مو لدرجات ال Viscosity مكيف عاليت جفا ، لان رح يكون Over thick وما ينزل

* How to control settling properties:

4. Viscosity enhancers (suspending agents or thickening agents)

- Ideally, the system should (rheologically) be **pseudoplastic**; that is, it should have **high viscosity at low shear rates** (during storage) and **low viscosity at high shear rates** (during shaking, pouring, or spreading).
- Thus selecting appropriate viscosity enhancer with desirable rheological properties
- Suspending agents which are pseudoplastic are desirable, since they recover slowly from the deformation that occurs through shearing (i.e. upon shaking, they remain fluid long enough to be poured and spread).




← بالتخزين ← ما ي حرق ←
 Thick on Standing
 ↓
 لمرأ ففصق
 رتورع نمام
 .. orally ←

$$V = \frac{d^2 (\rho_1 - \rho_2) g}{18 \eta_0}$$

28

28

liquid: → قمين (Newtonian → viscosity constant → water, Alcohol, Benzene)
 (Non-newtonian → viscosity ↓ → ketchup

How to control settling properties:

4. Viscosity enhancers (suspending agents or thickening agents)

- The rate of sedimentation may be appreciably reduced by increasing the viscosity of the dispersion medium
- However, a product having too high a viscosity is not generally desirable, because it pours with difficulty and it is equally difficult to redisperse the suspensoid.
- Therefore, if the viscosity of a suspension is increased, it is done so only to a modest extent to avoid these difficulties.

صاحب الخبز ←
دأءه الكرمه



29

29

How to control settling properties:

4. Viscosity enhancers (suspending agents or thickening agents):

- Viscosity enhancers include agents from each of the following categories. Typically, the concentrations used range from 0.5% to 5%, but the needed viscosity will depend on the suspended particle's tendency to settle:

1. **Natural hydrocolloids** → **بذوبه بالماي**
Acacia, tragacanth, alginic acid, carrageenan, locust bean gum, guar gum, gelatin.
← من مصدر طبيعي (الصمغ العربي)
2. **Semisynthetic hydrocolloids**
Methylcellulose, sodium carboxymethylcellulose
← معدل كيميائياً
3. **Synthetic hydrocolloids**
Carbopol® Poly(acrylic acid)
4. **Clays**
Bentonite, Veegum®
← طين

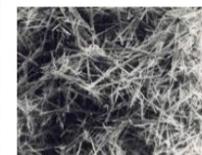
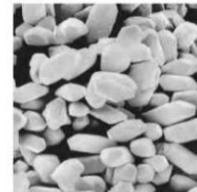
30

30

The particle shape can also affect caking and product stability:

• It has been shown that symmetrical barrel-shaped particles of calcium carbonate produced **more stable** suspensions than did asymmetrical needle-shaped particles of the same agent.

• The needle-shaped particles formed a firm sediment cake on standing that could not be redistributed, whereas the barrel-shaped particles did not cake upon standing



شکل الparticales ..
مُنْتَظِمَة (Sedimentation)
Cake ← يَجْعَلُ
قليلَة رَجْ يَكُونُ

سبب ال (tangling) (التشابك)
قوية Sedimentation
يَجْعَلُ Cake أشدَّ
(interaction Strong) ال
صَبْ نَصَبْ

31

tangling ↗ ★