2.3 Continuous Rotary Filters
连续旋转式过滤机

One very common filtration method in bioseparations is the continuous rotary filter. 旋转真空抽滤,又叫减压抽滤，是生物分离过程中常用的方法

It is used for more large scale antibiotic processing than all others combined. 抗生素生产中常用该方法

It is the preferred choice whenever the filtration is slow and difficult.常用在处理过滤速率慢、粘度高的发酵液中

We analyze the operation of these units, a filtration cycle on this filter consists of three chief steps:

一个完整的过滤过程主要为三个步骤：

Step 1 **cake formation, step 2 cake washing, step 3 cake discharge**

第一步滤饼的形成，第二步滤饼的洗涤，第三步滤饼的卸下

旋转真空抽滤（减压抽滤）过程的三个步骤

滤饼的形成 → 滤饼的洗涤 → 滤饼的卸下

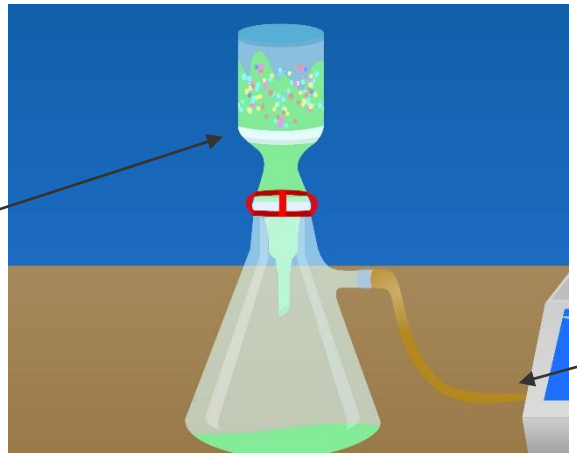
Step 1
cake formation

→

Step 2
cake washing

→

Step 3
cake discharge



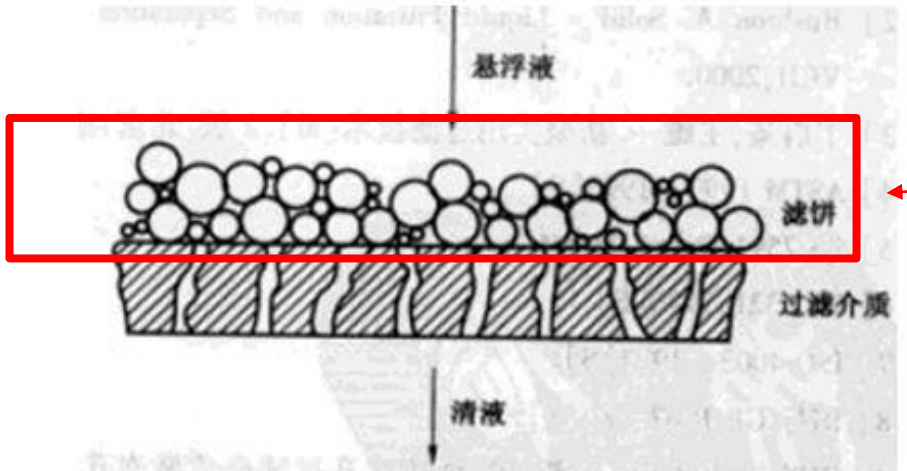
1. cake formation (滤饼的形成)

We first consider the cake formation which begins as the rotating drum first drops into the broth .

滤饼形成是从转鼓一开始接触培养基开始的。

we assume that the resistance of the filter medium R_M is negligible, so that we can use equation (1) the basic expression for filtration: *

假设过滤介质的阻力R_M可忽略不计，可以用下式（1）表示：



（滤饼过滤示意图 5）

滤饼

$$\frac{1}{A}\frac{dV}{dt}=\frac{\Delta p}{\mu Rc}$$ (式 1)

As before, this is subject to initial condition that

初始条件是

$$t=0 \qquad V=0$$

We rewrite R_C for a compressible cake by combining Eqs.(2.2-6) and (2.2-13)

$$R_C=\alpha\rho_0(V/A)$$

$$=\alpha'\rho_0(V/A)(\triangle p)^s$$ (式 2)

$$t_f = \frac{\mu \alpha' \rho_0}{2(\Delta p)^{1-s}} \left(\frac{V_f}{A} \right)^2 \qquad \text{(式 3)}$$

t_f - the cake formation time

滤饼形成时间

V_f - the volume of filtrate collected during that period.

滤饼形成期间的滤液体积（滤液流量）

This relationship is sometimes written in terms of the cycle time t_c :

$$t_f = \beta t_c \qquad \text{(式 4)}$$

β—the fraction of time that the filter is submerged

过滤器被浸渍的时间分数

t_f—the fraction of the cycle devoted to cake formation

即旋转周期形成滤饼的时间分数

t_c—the cycle time

旋转周期

We find a relation for filtration flux expressed in terms of cycle time:

用旋转周期表示为

$$\frac{V_f}{At_c} = \left[\frac{2\beta(\Delta p)^{1-s}}{\mu\alpha'\rho_0 t_c} \right]^{1/2} \qquad \text{(式 5)}$$

2. cake washing （滤饼的洗涤）

After formation, the cake contains a significant amount of solute-rich liquid broth. This broth is usually removed by washing the cake.

滤饼形成以后，滤饼中残留的发酵液用洗涤的方法除去。

The washing has two functions：

洗涤有两个作用

First, it displaces the solution-rich broth trapped in pores in the cake.

将滤饼孔内含有的发酵液洗出。

Second, it allows diffusion of solute out of the biomass in the cake. Such diffusion will enhance recovery if the desired product is in the biomass.

滤饼中，溶质可以从生物机体中扩散出，如果目标产物存在于生物机体中，这种扩散可以提高回收。

Two factors are involved in the washing :

滤饼洗涤包括两个因素

First, fraction of soluble material remaining after the wash, this governs the volume of wash liquid required.

洗涤之后残留可溶物质的分数，这个分数决定着洗液体积。

Second, the rate at which wash liquid passed through the cake, this rate of wash controls the time of the cycle devoted to washing.

洗液过滤饼速率，这个速率控制着时间。

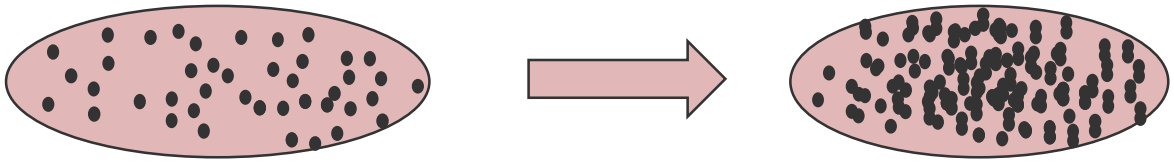
The fraction of soluble material remaining is often related to the volume of wash liquid by the equation.

残留可溶物分数常与洗液量有关

$$r=(1-\varepsilon)^n \qquad \text{(式6)}$$

***r*-the ratio of solubles remaining after the wash to that originally present in the cake prior to the wash.**

r为洗涤之后的溶质含量与洗涤之前滤饼中最初溶质含量比。



洗涤之后的滤饼　　洗涤之前的滤饼

- ***n*-the volume of wash liquid divided by the volume of the liquid retained in the cake.**

  洗液的体积与滤饼中残液的体积之比

ε-washing efficiency of the cake

  滤饼的洗涤效率

- **the fraction *r* varies from 0～1.**
- **lower values of *r* correspond to more effective washing.**

  r值低，洗涤效果好

If ε=0 means that r=1 and we get no reduction of solubles， no matter what volume of wash is used.

如果ε=0 r=1，此时不论使用多少洗液均没有效果。

r=0 ε=1 more effective washing.

洗涤效果很好

r=1 ε=0 no reduction of soluble.

Equation (2.3-7) is an empirical result from a variety of filtrations.

式2.3-7是大量实践得到的经验方程式。

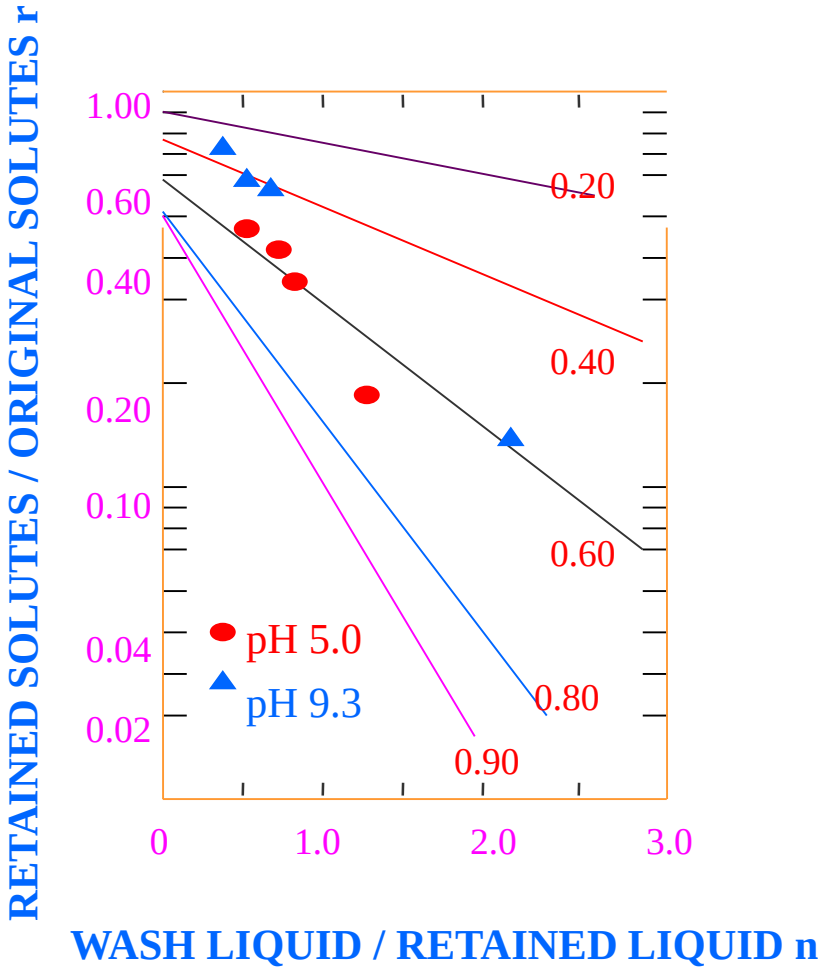


Figure 2.3-1 Efficiency of washing

图2.3-1 洗涤效率

Data for measurements at two values of pH show that efficiency does vary with pH. 两个不同pH值下的测量数据说明效率随着pH变化而变化。

#Thus we can estimate how mush wash liquid will be needed to wash the cake ,

我们可以估计洗涤滤饼所需要洗涤液的用量,

which was the first of the key factors here . We now turn to how fast this liquid will flow though the cake , which is the second key factor.

这是第一个主要的因素。现在我们开始讨论另一个因素—— 洗液流速。

The wash liquid contains no additional solids , so the flow of wash liquid will be constant and equal to the final instantaneous filtrate rate at the end of the cake formation. This rate is

洗液不包含所加的固体物，因此，洗液的流量是一个常量，且等于滤饼形成的最后瞬间过滤液的速率，这个速率是：

$$\frac{V_w}{A}=\left[\frac{(\Delta p)^{1-s}}{2\mu\alpha'\rho_0 t_f}\right]^{1/2} t_w \qquad \text{(式 7)}$$

V_w-- the volume of wash water required

所需洗液体积

t_w-- the time required for washing

所需洗涤时间

Chapter 2（习题）

1、何谓过滤

2、过滤的基本形式

3、凝聚和絮凝的区别

4、常用的絮凝剂有哪些

5、过滤设备分类

6、常用过滤设备及其特点