GIDA MÜHENDİSLİĞİ BÖLÜMÜ

Department of Food Engineering

Proses Tasarımı Ders Sunumu

Dersin Adı: GM 314 – Proses Tasarımı

Dersin Hocası: Doç. Dr. Ahmet AKKÖSE

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Proses Akım Şemaları

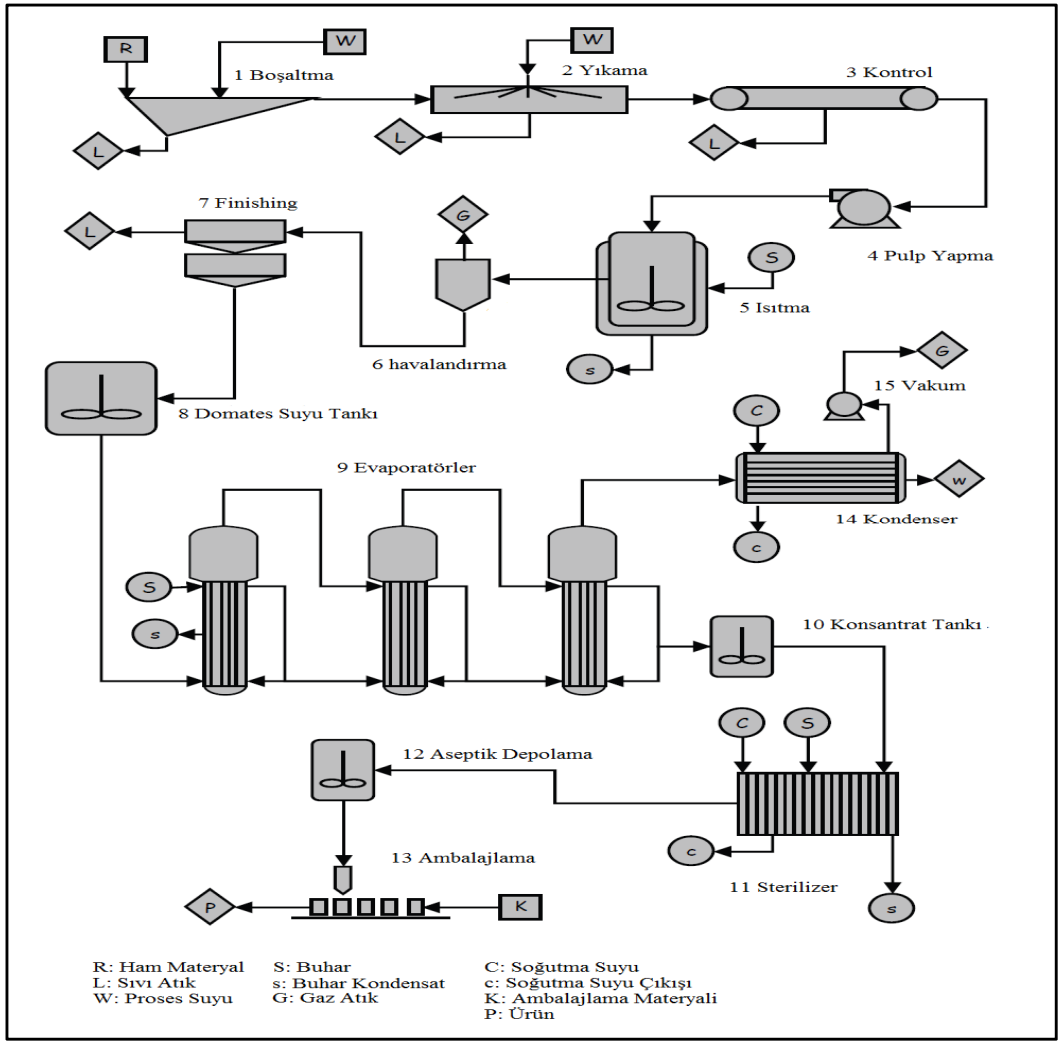
PROSES

AKIM ŞEMALARININ

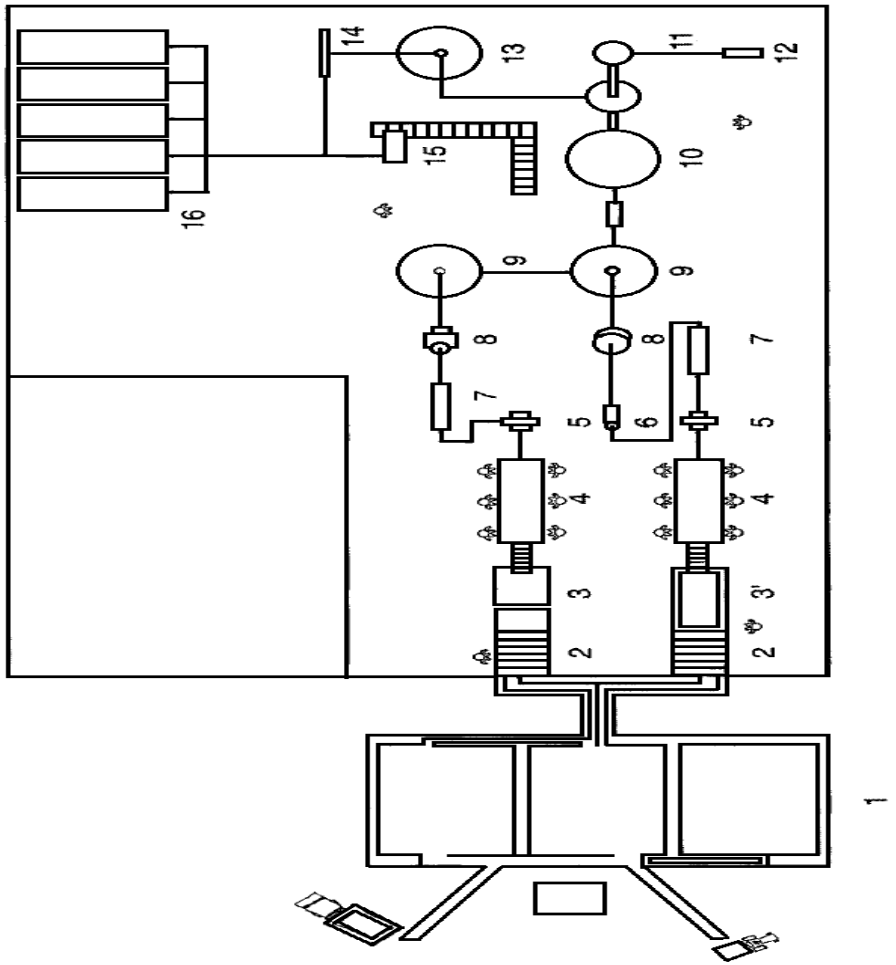
OLUŞTURULMASI

PROSES BLOK DİYAGRAMI

PROSES AKIŞ DİYAGRAMI

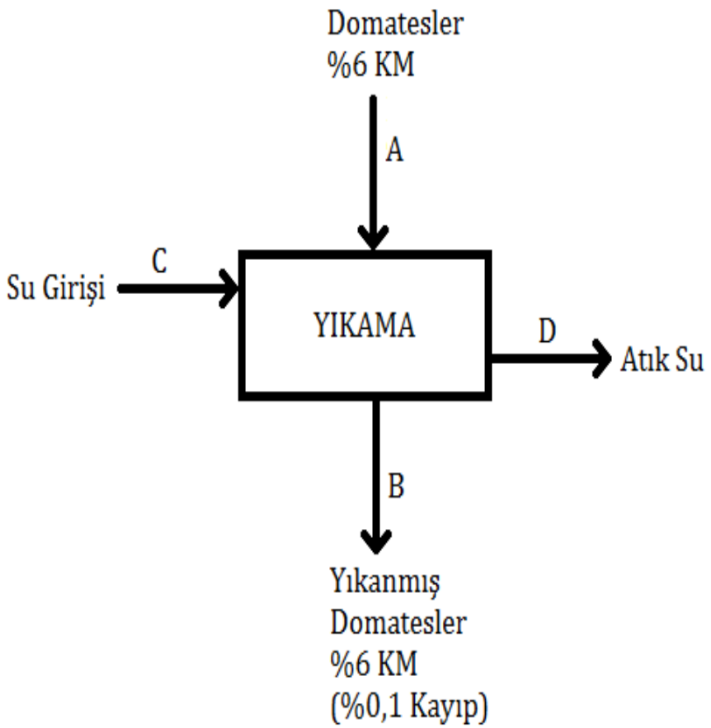


PROSES DÜZEN DİYAGRAMI



Şekil: Domates Salçası Üreten Bir İşletme İçin Ekipman Düzen Diyagramı (Zemin Planı)

Kütle ve Enerji Denklikleri



$$A = 12{,}13\ ton/h$$

$$C = 36{,}39\ ton/h$$

$$B = 12{,}13 - \frac{12{,}13 \times 0{,}1}{100}$$

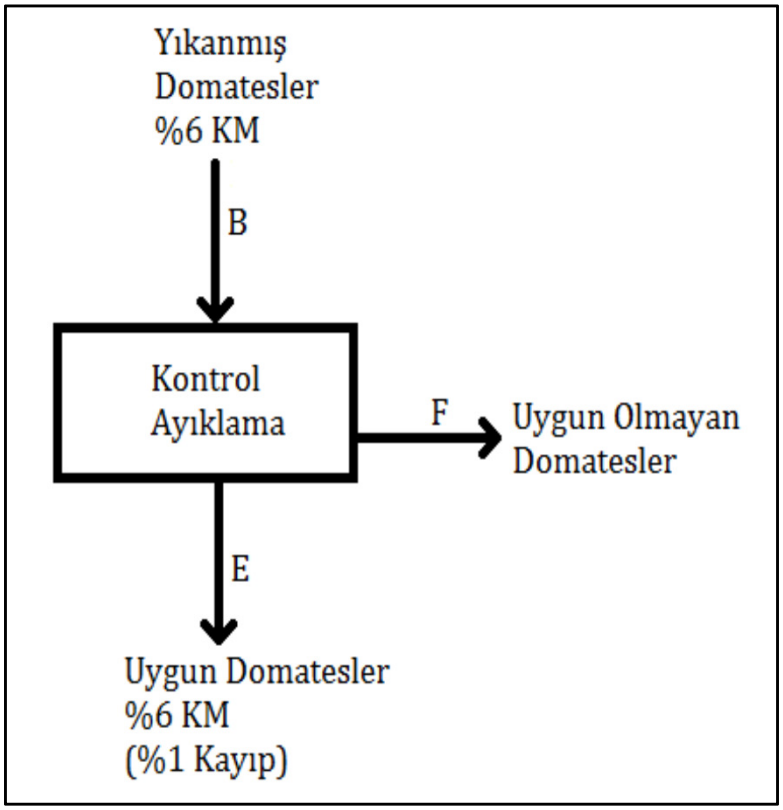
$$B = 12{,}12\ ton/h$$

$$TKD: A + C = B + D$$

$$12{,}13 + 36{,}39 = 12{,}12 + D$$

$$D = 36{,}4\ ton/h$$

Kütle ve Enerji Denklikleri



$$B = 12{,}12\ ton/h$$

$$E = 12{,}12 - \frac{12{,}12 \times 1}{100}$$

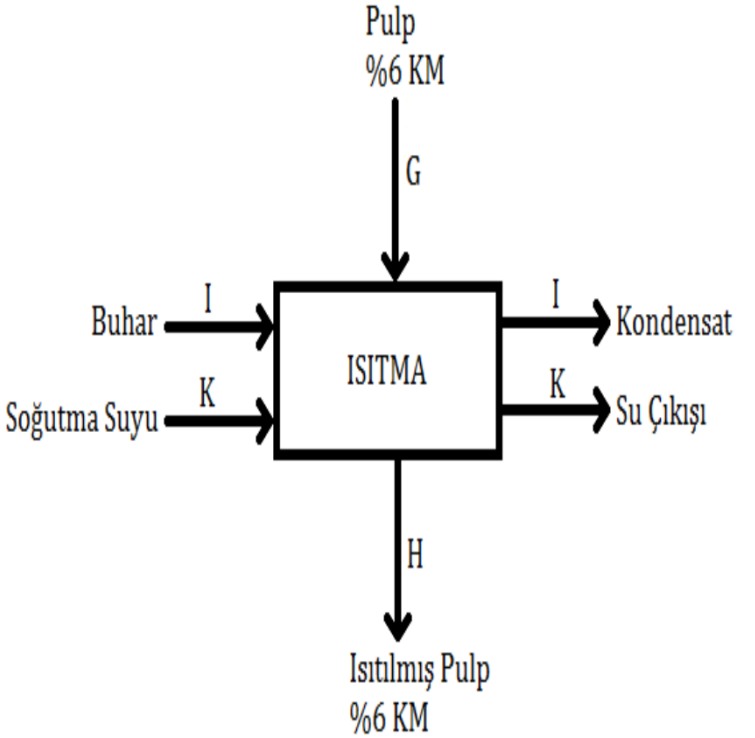
$$E = 12\ ton/h$$

$$TKD: B = E + F$$

$$12{,}12 = 12 + F$$

$$F = 0{,}12\ ton/h$$

Kütle ve Enerji Denklikleri



➢ *Buhar için:*

$$M_g \times Cp_g \times \Delta T_g = M_b \times (H_b - H_k)$$

$$Cp_g = 3349 \times 0{,}94 + 837{,}36 \cong 3985\ J/kgK = 3{,}985\ kJ/kgK$$

$$H_b(T = 120°C) = 2706{,}3\ kJ/kg$$

$$H_k(T = 85°C) = 355{,}90\ kJ/kg$$

$$(12000\ kg/h)(3{,}985\ kJ/kgK)(93 - 20)°C = M_b(2706{,}3 - 355{,}90)\ kJ/kg$$

$$M_b \cong 1485\ kg/h \cong 1{,}5\ ton/h$$

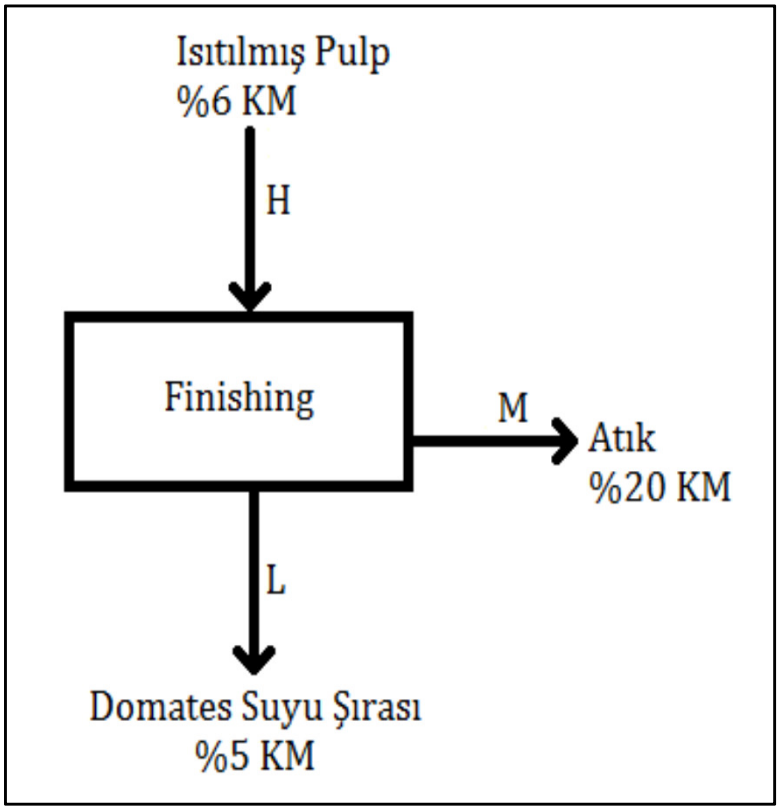
➢ *Su için:*

$$M_g \times Cp_g \times \Delta T_g = M_s \times Cp_s \times \Delta T_s$$

$$(12000\ kg/h)(3{,}985\ kJ/kgK)(93 - 40)°C = M_s(4{,}18\ kJ/kgK)(60 - 15)°C$$

$$M_s \cong 13474\ kg/h \cong 13{,}5\ ton/h$$

Kütle ve Enerji Denklikleri



$$H = 12\ ton/h$$

$$TKD: H = L + M$$

$$12 = L + M \Longrightarrow M = 12 - L$$

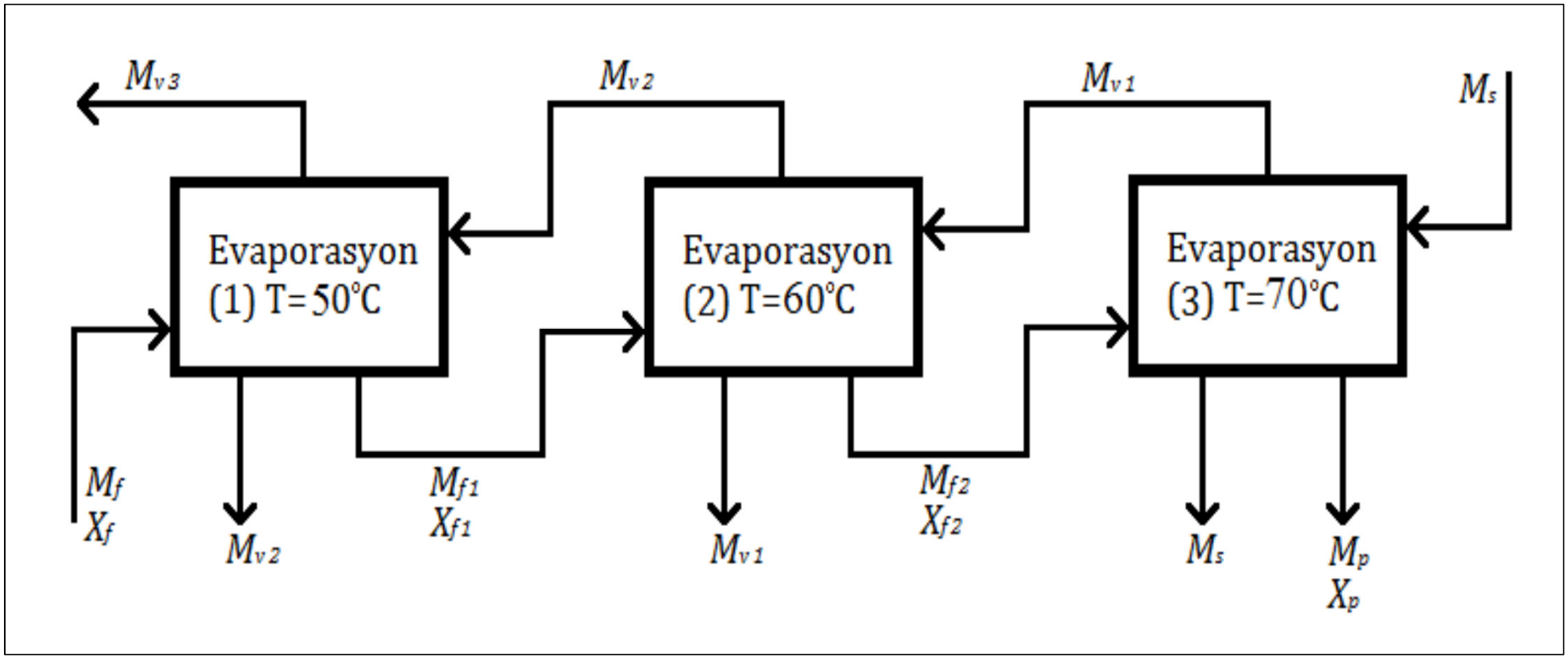
$$BD: \frac{6H}{100} = \frac{5L}{100} + \frac{20M}{100}$$

$$(6)(12) = (5)(L) + (20)(12 - L)$$

$$L = 11{,}2\ ton/h$$

$$M = 0{,}8\ ton/h$$

Kütle ve Enerji Denklikleri



Kütle ve Enerji Denklikleri

$$TKD:\ M_f = M_{v1} + M_{v2} + M_{v3} + M_p \implies 11{,}2 = M_{v1} + M_{v2} + M_{v3} + M_p$$

$$BD: M_f x_f = M_{f1} x_{f1} \implies (11{,}2)(0{,}05) = M_{f1}(0{,}12) \implies M_{f1} = 4{,}67\ ton/h$$

$$M_{f1} x_{f1} = M_{f2} x_{f2} \implies (4{,}67)(0{,}12) = M_{f2}(0{,}20) \implies M_{f2} = 2{,}8\ ton/h$$

$$M_{f2} x_{f2} = M_p x_p \implies (2{,}8)(0{,}20) = M_p(0{,}28) \implies M_p = 2\ ton/h$$

$$11{,}2 = M_{v1} + M_{v2} + M_{v3} + 2 \implies M_{v1} + M_{v2} + M_{v3} = 9{,}2\ ton/h$$

Kütle ve Enerji Denklikleri

Enerji Denklikleri:

$$M_f H_f + M_{v2} H_{v2} = M_{f1} H_{f1} + M_{v2} H_{c2} + M_{v3} H_{v3}$$

$$M_{f1} H_{f1} + M_{v1} H_{v1} = M_{f2} H_{f2} + M_{v1} H_{c1} + M_{v2} H_{v2}$$

$$M_{f2} H_{f2} + M_s H_s = M_p H_p + M_s H_c + M_{v1} H_{v1}$$

$$C_{pf} = 3349(0{,}95) + 837{,}36 \cong 4018\, J/kgK \cong 4\, kJ/kgK$$

$$C_{pf1} = 3349(0{,}88) + 837{,}36 \cong 3784\, J/kgK \cong 3{,}784\, kJ/kgK$$

$$C_{pf2} = 3349(0{,}80) + 837{,}36 \cong 3517\, J/kgK \cong 3{,}517\, kJ/kgK$$

$$C_{pp} = 3349(0{,}72) + 837{,}36 \cong 3249\, J/kgK \cong 3{,}249\, kJ/kgK$$

$$H_f = C_{pf}(T_f - T_R) = (4)(40 - 0) = 160\, kJ/kg$$

$$H_{f1} = C_{pf1}(T_{f1} - T_R) = (3{,}784)(50 - 0) \cong 189\, kJ/kg$$

$$H_{f2} = C_{pf2}(T_{f2} - T_R) = (3{,}517)(60 - 0) \cong 211\, kJ/kg$$

$$H_p = C_{pp}(T_p - T_R) = (3{,}249)(70 - 0) = 227\, kJ/kg$$

$H_s(T_s = 120℃) = 2706{,}3\, kJ/kg$ $\quad$ $H_c(T_c = 70℃) = 292{,}98\, kJ/kg$

$H_{v1}(T_{v1} = 70℃) = 2626{,}8\, kJ/kg$ $\quad$ $H_{c1}(T_{c1} = 60℃) = 251{,}13\, kJ/kg$

$H_{v2}(T_{v2} = 60℃) = 2609{,}6\, kJ/kg$ $\quad$ $H_{c2}(T_{c2} = 50℃) = 209{,}33\, kJ/kg$

$H_{v3}(T_{v3} = 50℃) = 2592{,}1\, kJ/kg$ $\quad$ $H_w(T_w = 15℃) = 62{,}99\ kJ/kg$

$$(2{,}8)(211) + M_s(2706{,}3) = (2)(227{,}43) + M_s(292{,}98) + M_{v1}(2626{,}8)$$

$$\Longrightarrow M_{v1} = 0{,}05 + 0{,}92 M_s$$

$$(4{,}67)(189{,}2) + M_{v1}(2626{,}8) = (2{,}8)(211) + M_{v1}(251{,}13) + M_{v2}(2609{,}6)$$

$$M_{v2} = 0{,}11 + 0{,}91 M_{v1} \Longrightarrow M_{v2} = 0{,}11 + 0{,}91(0{,}05 + 0{,}92 M_s) \Longrightarrow M_{v2} = 0{,}16 + 0{,}84 M_s$$

$$(11{,}2)(160) + M_{v2}(2609{,}6) = (4{,}67)(189{,}2) + M_{v2}(209{,}33) + M_{v3}(2592{,}1)$$

$$M_{v3} = 0{,}35 + 0{,}93 M_{v2} \Longrightarrow M_{v3} = 0{,}35 + 0{,}93(0{,}16 + 0{,}84 M_s) \Longrightarrow M_{v3} = 0{,}50 + 0{,}78 M_s$$

$$M_{v1} + M_{v2} + M_{v3} = 9{,}2 = 0{,}05 + 0{,}92 M_s + 0{,}16 + 0{,}84 M_s + 0{,}50 + 0{,}78 M_s$$

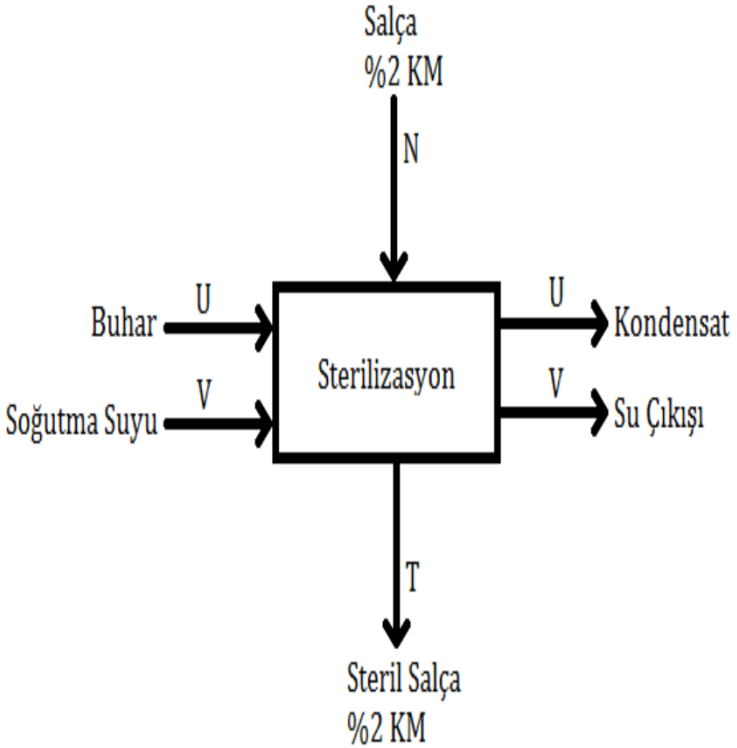
$M_s = 3{,}34\ ton/h$ $\quad$ $M_{v2} = 2{,}97\, ton/h$

$M_{v1} = 3{,}12\, ton/h$ $\quad$ $M_{v3} = 3{,}11\, ton/h$

Soğutma Suyu Ihtiyacı: $M_{v3}(H_{v3} - H_{c2}) = M_w(H_{c2} - H_w)$

$$(3{,}11)(2592{,}1 - 209{,}33) = M_w(209{,}33 - 62{,}99) \Longrightarrow M_w \cong 50{,}64\ ton/h$$

Kütle ve Enerji Denklikleri



➢ *Buhar için:*

$$M_g \times Cp_g \times \Delta T_g = M_b \times (H_b - H_k)$$

$$Cp_g = 3349 \times 0{,}74 + 837{,}36 \cong 3249\ J/kgK = 3{,}249 kJ/kgK$$

$$H_b(T = 120°C) = 2706{,}3\ kJ/kg$$

$$H_k(T = 85°C) = 355{,}90\ kJ/kg$$

$$(2000\ kg/h)(3{,}249 kJ/kgK)(110 - 70)°C = M_b(2706{,}3 - 355{,}90)\ kJ/kg$$

$$M_b \cong 111\ kg/h \cong 0{,}111\ ton/h$$

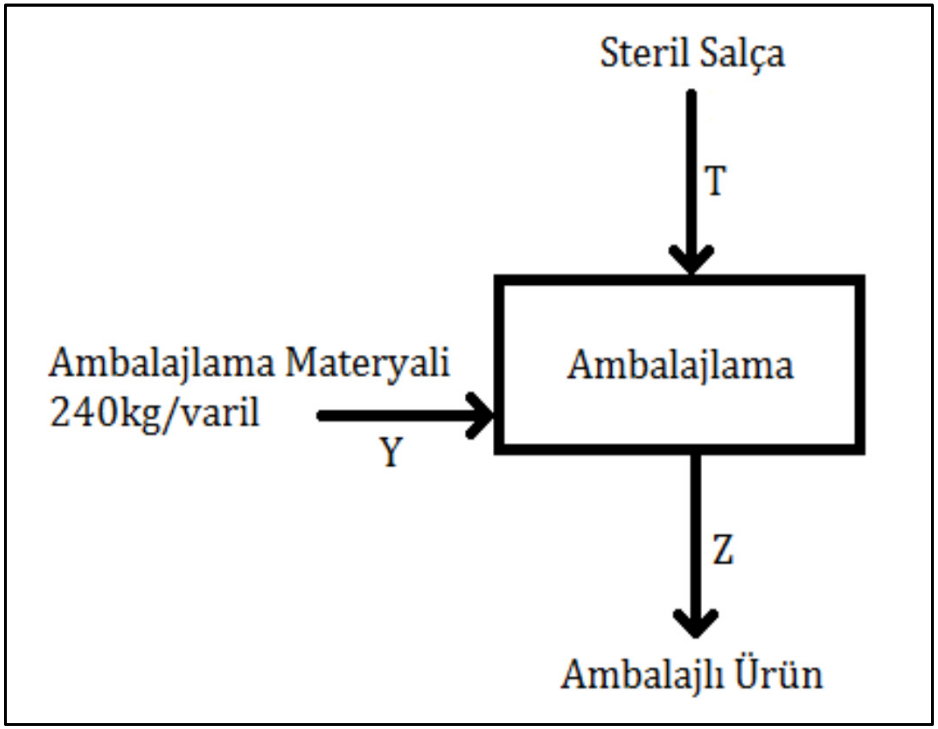
➢ *Su için:*

$$M_g \times Cp_g \times \Delta T_g = M_s \times Cp_s \times \Delta T_s$$

$$(2000\ kg/h)(3{,}249 kJ/kgK)(110 - 30)°C = M_s(4{,}18\ kJ/kgK)(40 - 15)°C$$

$$M_s \cong 4975\ kg/h \cong 5\ ton/h$$

Kütle ve Enerji Denklikleri



$1 Varil$	$240 kg\ salça$
$kaç\ varil$	$2000 kg\ salça$

$$8{,}33\ varil/h$$

PROSES

BLOK

DİYAGRAMI