



# SYSTÈMES DE POMPAGE

RÉGULATION DES SYSTÈMES DE POMPAGE

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UNIVERSIDAD DE CASTILLA-LA MANCHA

FORMATION EN LIGNE - 16 DÉCEMBRE 2020



# CONTRÔLE DU SYSTÈME DE POMPAGE

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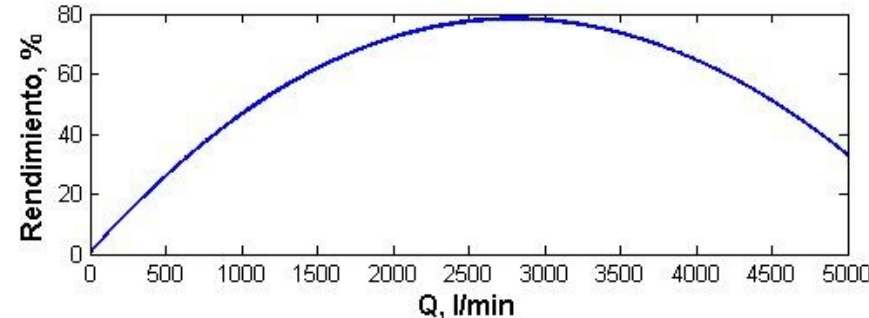
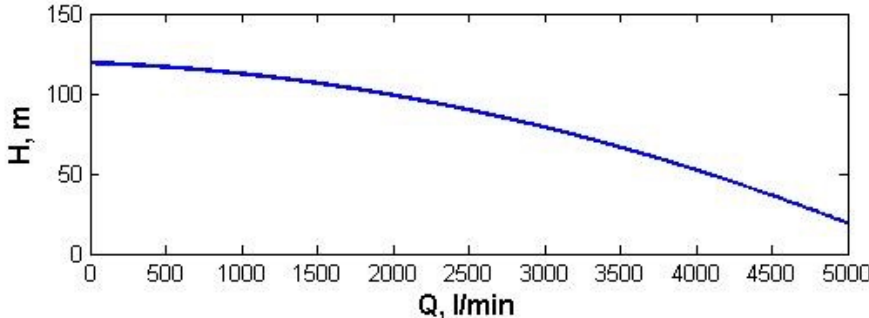


- Lorsque le débit ou la pression sont élevés, associer généralement plusieurs pompes en parallèle ou en série est une meilleure option que d'installer une grande pompe.
- Lors de l'installation de plusieurs pompes, il est nécessaire de réguler l'activation des différentes pompes.
- Connexion en série pour augmenter la pression.

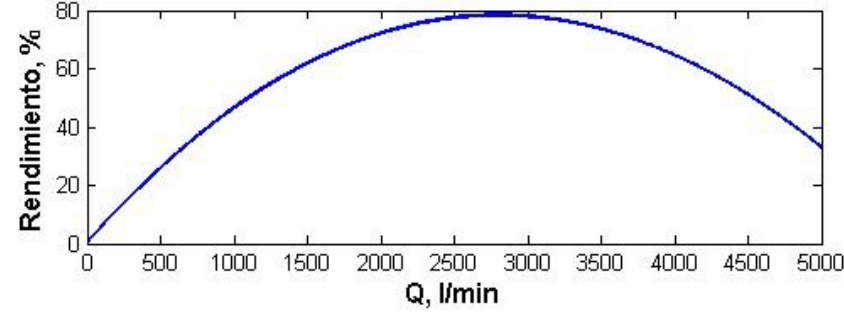
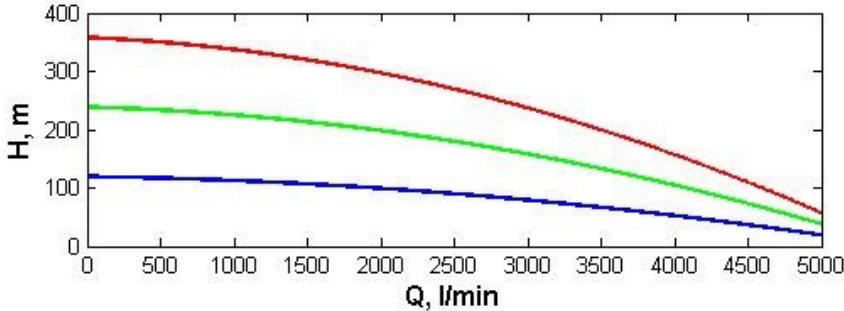
# CONTRÔLE DU SYSTÈME DE POMPAGE



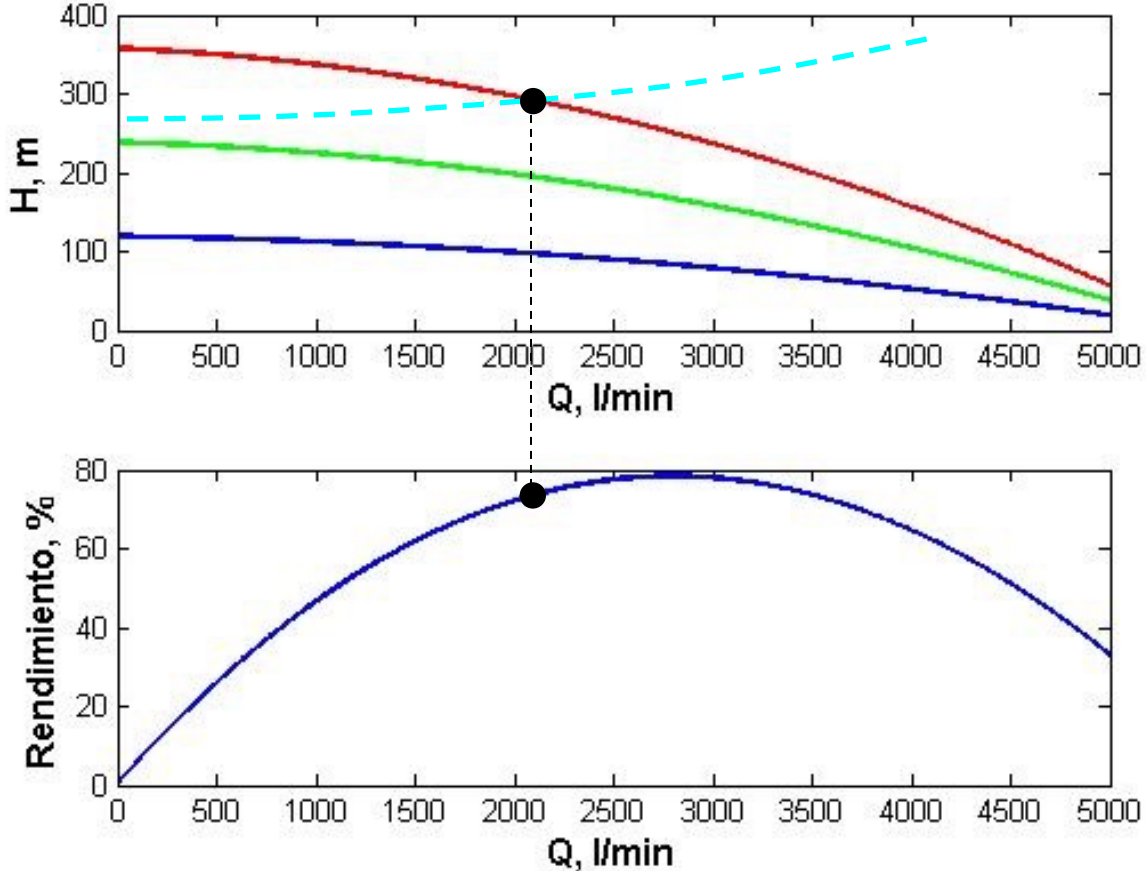
1 pompe



3 pompes en série

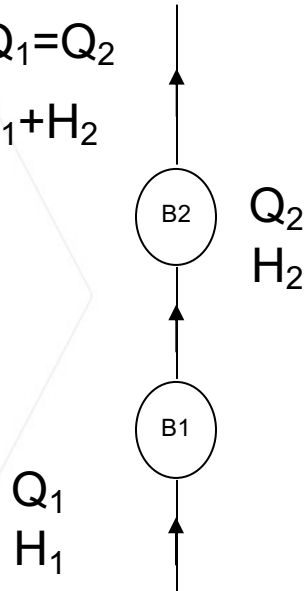


# CONTRÔLE DU SYSTÈME DE POMPAGE

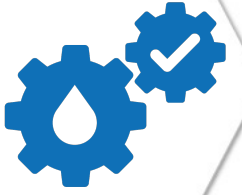


$$Q_T = Q_1 = Q_2$$

$$H_T = H_1 + H_2$$



# CONTRÔLE DU SYSTÈME DE POMPAGE



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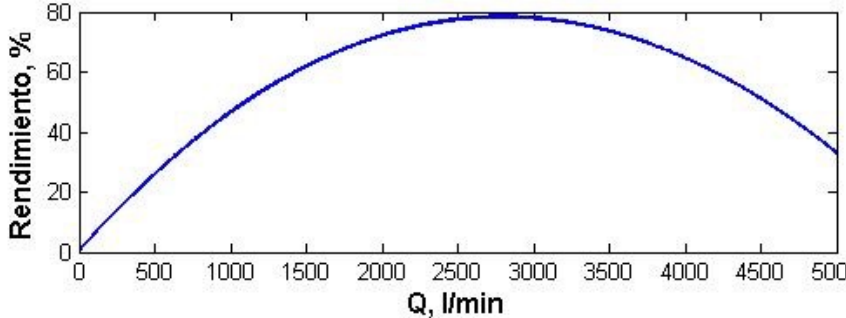
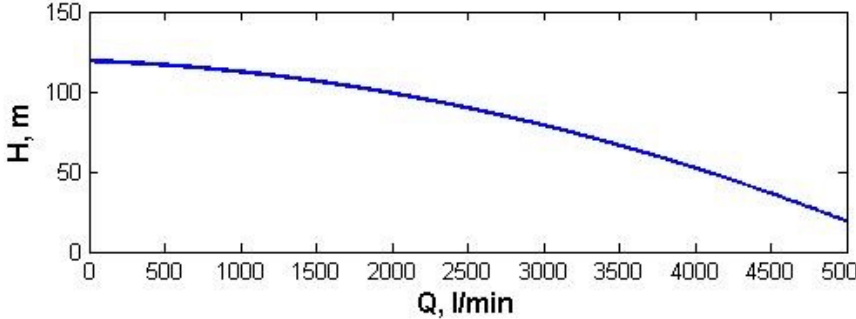


- Lorsque le débit ou la pression sont élevés, associer généralement plusieurs pompes en parallèle ou en série est une meilleure option que d'installer une grande pompe.
- Lors de l'installation de plusieurs pompes, il est nécessaire de réguler l'activation des différentes pompes.
- Connexion en série pour augmenter la pression.
- Connexion en parallèle pour augmenter débit.

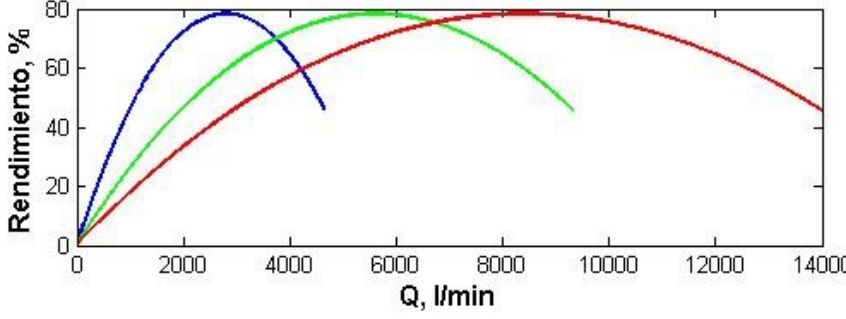
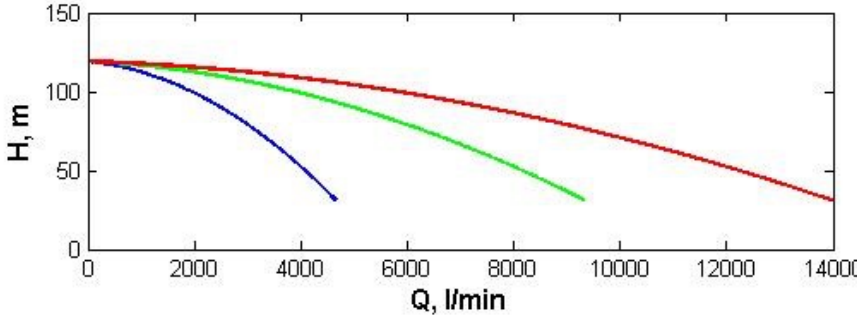
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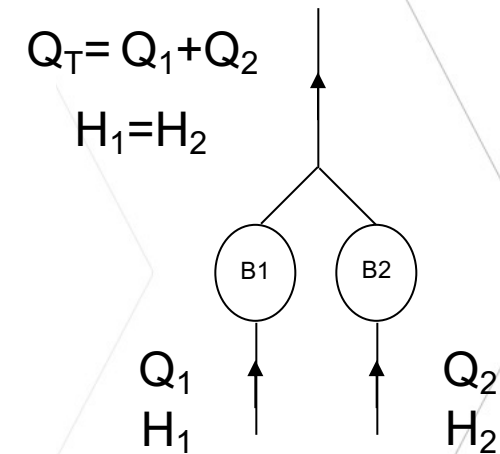
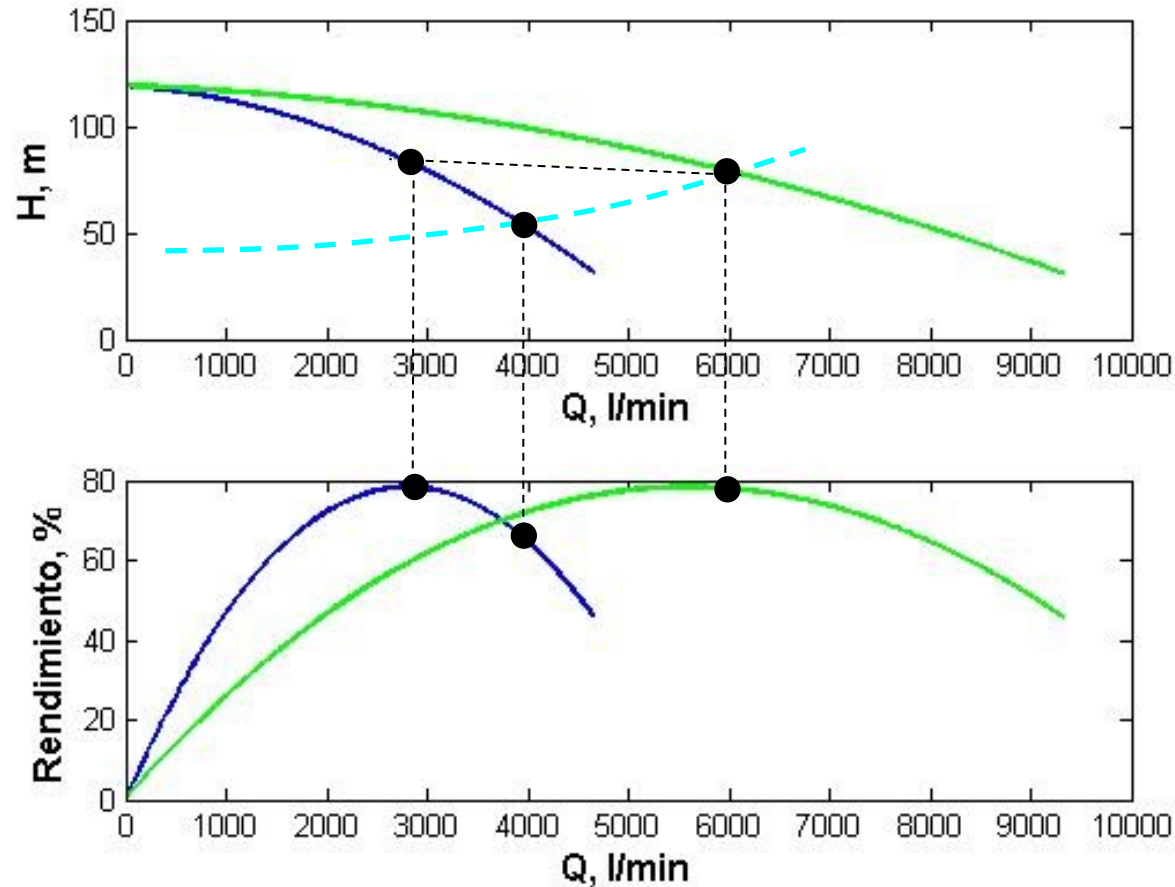
1 pompe



3 pompes en parallèle



# CONTRÔLE DU SYSTÈME DE POMPAGE



**Si on associe 2 pompes en parallèle elles ne fournissent pas le double de débit!!**



# CONTRÔLE DU SYSTÈME DE POMPAGE



# CONTRÔLE DU SYSTÈME DE POMPAGE

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- **Régulation des stations de pompage.**
  - **Régulation manométrique, contrôlée par un transducteur de pression.**
  - **Régulation suivant la courbe du système.**
    - Régulation suivant une courbe système calculée. Contrôlé avec un débitmètre.
    - Régulation suivant une courbe système dynamique. Contrôlé avec un débitmètre et plusieurs transducteurs de pression situés dans le réseau d'irrigation.



**UNIVERSIDAD DE CASTILLA-LA MANCHA**



**Analysis of energy efficiency of pumping stations**

**(MAEEB)**

**Versión 2.0**

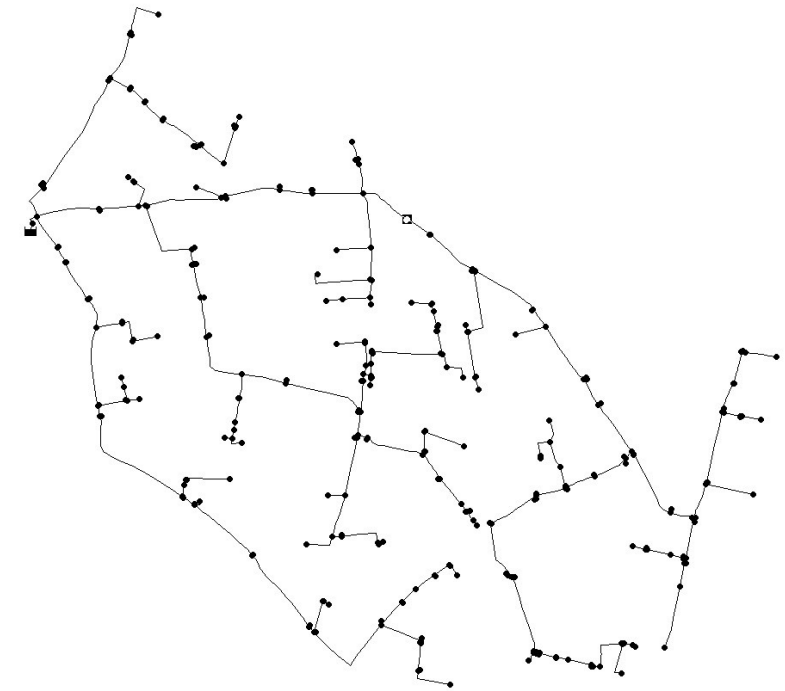
**November 2020**

# CONTRÔLE DU SYSTÈME DE POMPAGE



Régulation manométrique

H=45 m



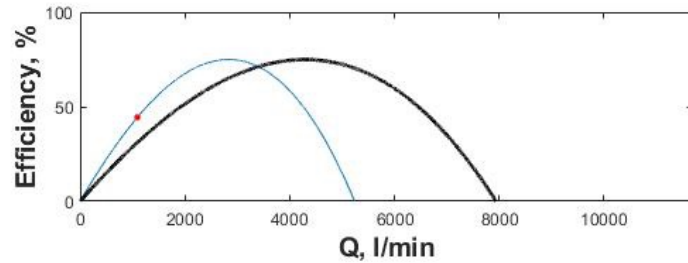
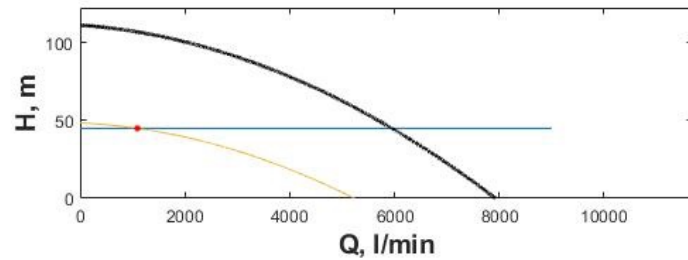
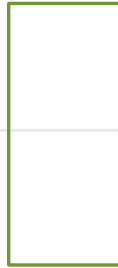
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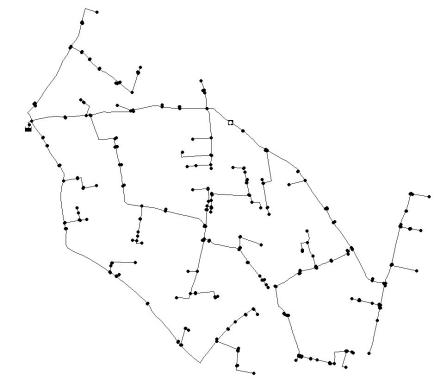
INDAR 257-3



$Q=1094 \text{ l/min}$   
 $H=45 \text{ m}$   
 $\eta=44.4\%$



Débit demandé  
 $Q=1094 \text{ l/min}$  ( 5%)



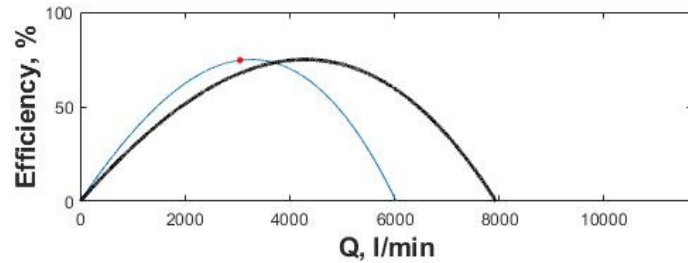
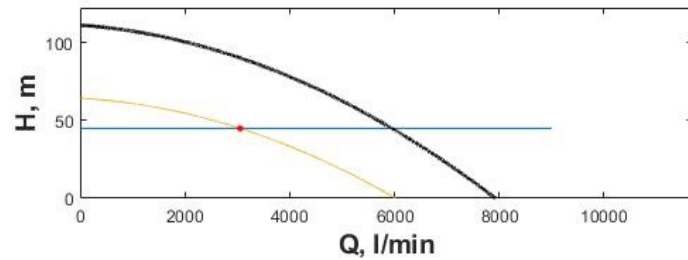
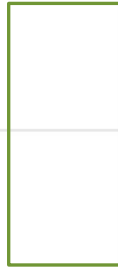
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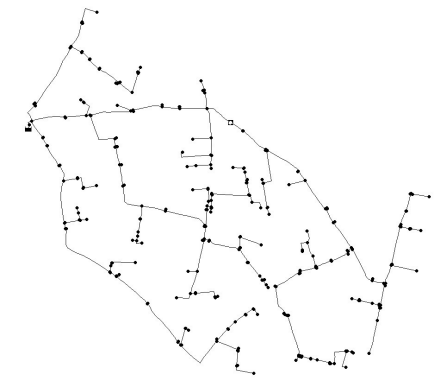
INDAR 257-3



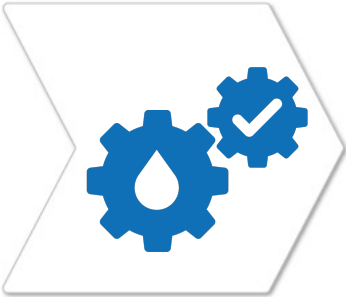
$Q=3054$  l/min  
 $H=45$  m  
 $\eta=74.6\%$



Débit demandé  
 $Q=3054$  l/min (13%)



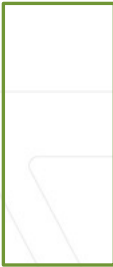
# CONTRÔLE DU SYSTÈME DE POMPAGE



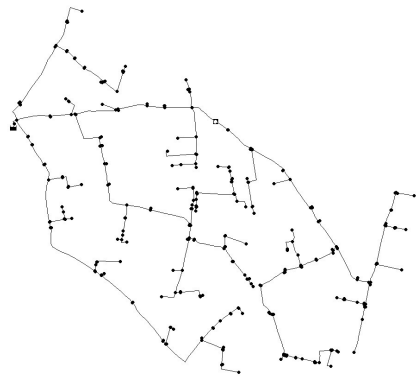
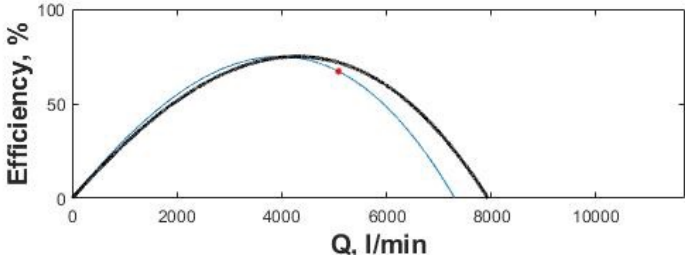
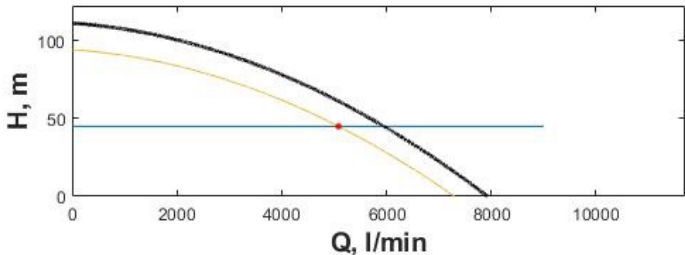
INDAR 257-3



$Q=5085$  l/min  
 $H=45$  m  
 $\eta=67.1\%$



Débit demandé  
 $Q=5085$  l/min (21%)



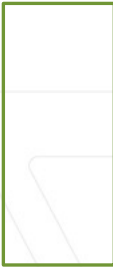
# CONTRÔLE DU SYSTÈME DE POMPAGE



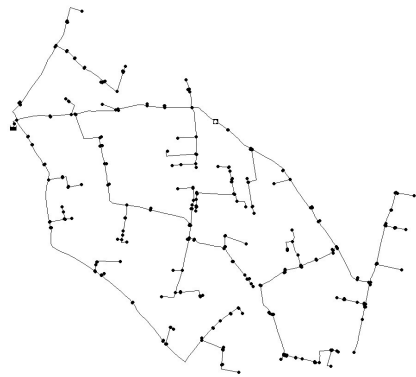
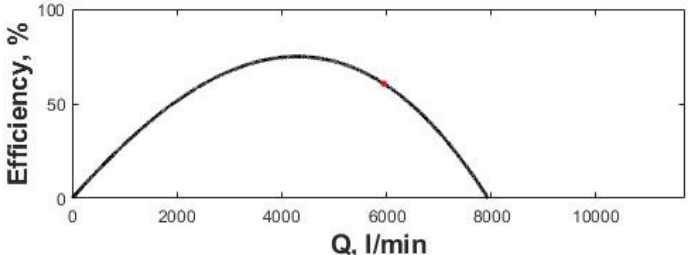
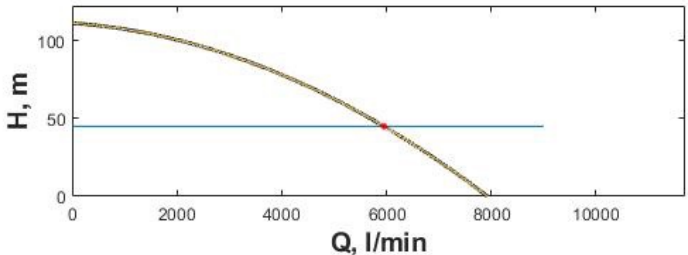
INDAR 257-3



$Q=5952 \text{ l/min}$   
 $H=45 \text{ m}$   
 $\eta=60.5\%$

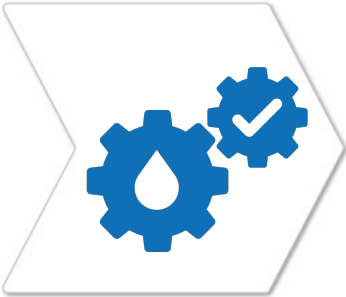


Débit demandé  
 $Q=5952 \text{ l/min (25\%)}$





# CONTRÔLE DU SYSTÈME DE POMPAGE



INDAR 257-3



Q=1094 l/min  
H=45 m  
 $\eta=44.4\%$

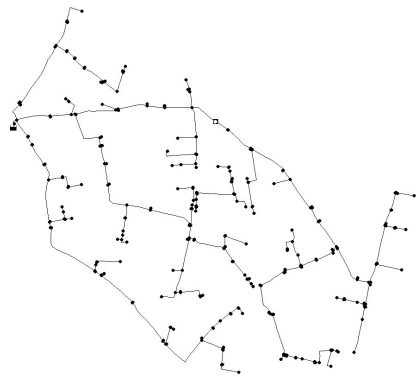
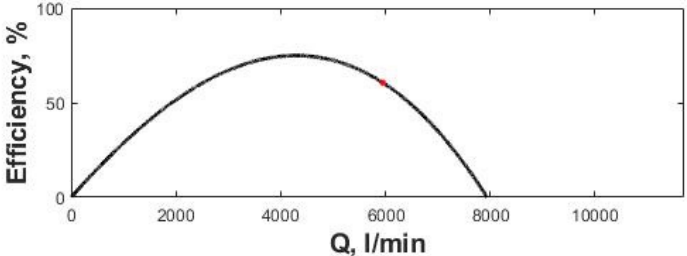
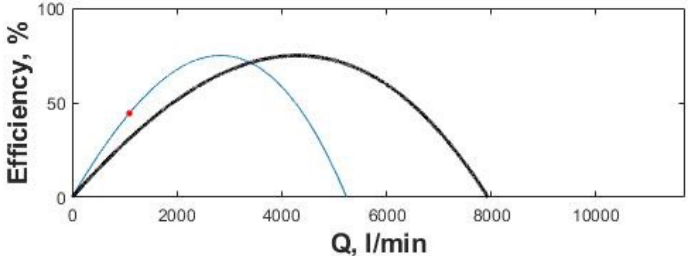
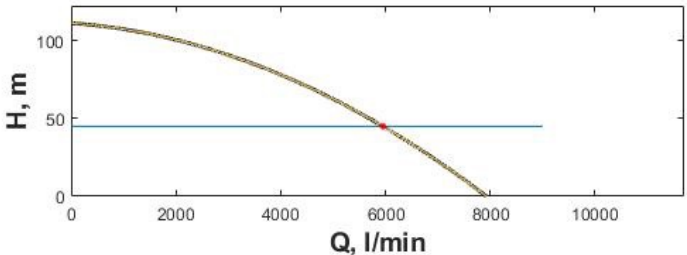
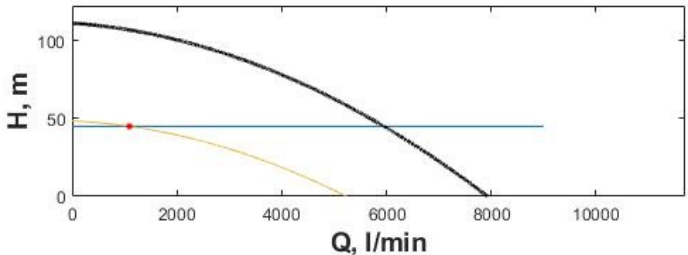


Q=5952 l/min  
H=45 m  
 $\eta=60.5\%$



$$\eta = \frac{1094 \cdot 44.4 + 5952 \cdot 60.5}{7046} = 58\%$$

Débit demandé  
Q=7046 l/min (30%)



# CONTRÔLE DU SYSTÈME DE POMPAGE



INDAR 257-3



Q=3054 l/min  
H=45 m  
 $\eta=74.6\%$

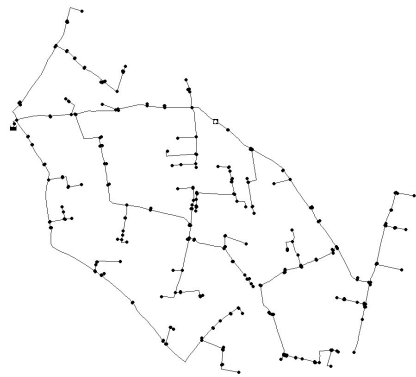
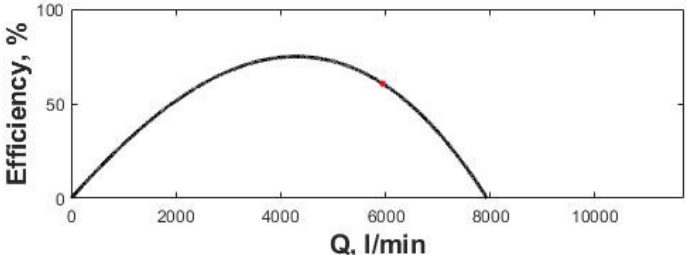
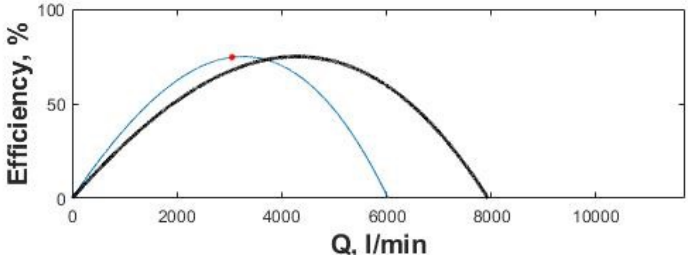
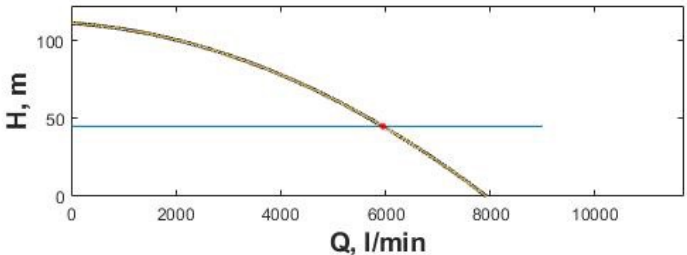
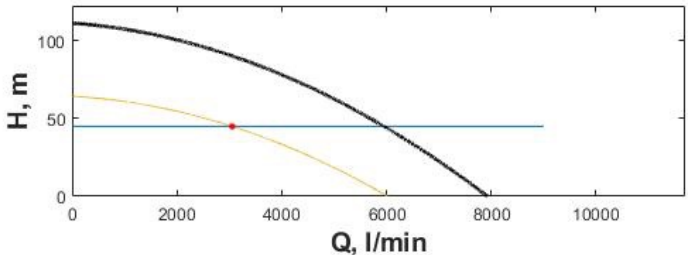


Q=5952 l/min  
H=45 m  
 $\eta=60.5\%$



$$\eta = \frac{3054 \cdot 74,6 + 5952 \cdot 60,5}{9006} = 65,3\%$$

Débit demandé  
Q=9006 l/min (38%)



# CONTRÔLE DU SYSTÈME DE POMPAGE



INDAR 257-3



Q=5085 l/min  
H=45 m  
 $\eta=67.1\%$

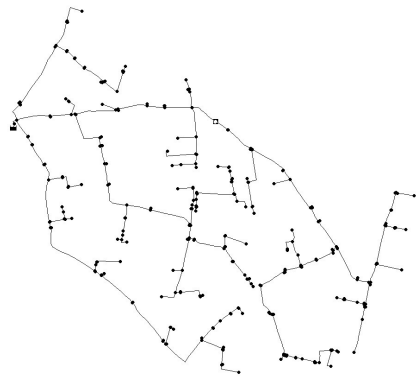
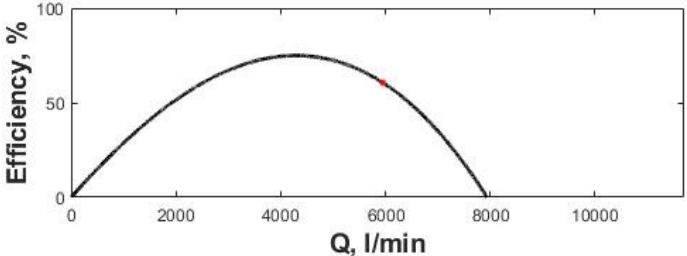
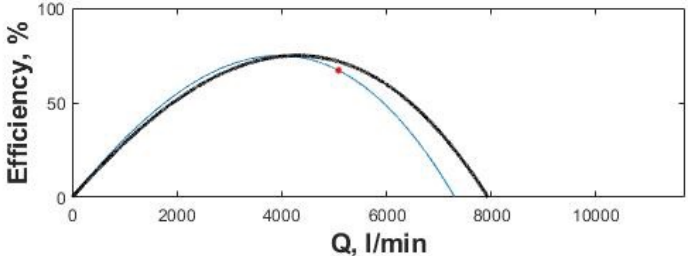
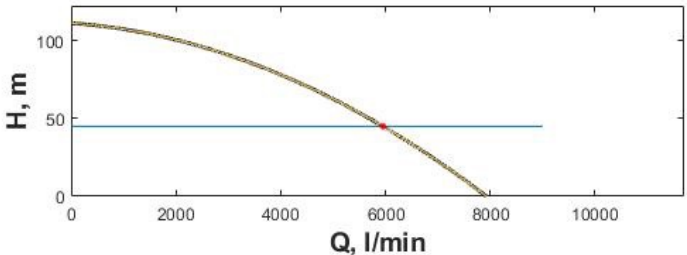
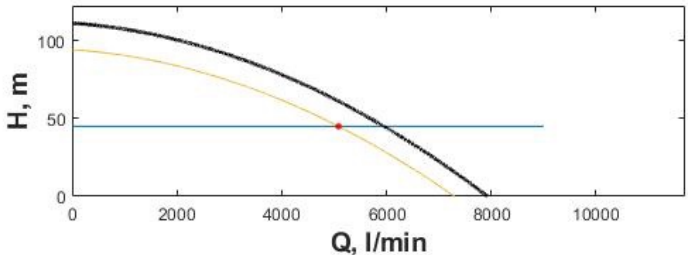


Q=5952 l/min  
H=45 m  
 $\eta=60.5\%$



$$\eta = \frac{5085 \cdot 67.1 + 5952 \cdot 60.5}{11037} = 77.9\%$$

Débit demandé  
Q=11037 l/min (46%)



# CONTRÔLE DU SYSTÈME DE POMPAGE



INDAR 257-3



Q=5952 l/min  
H=45 m  
 $\eta=60.5\%$

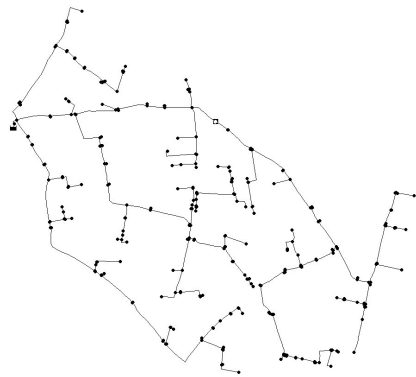
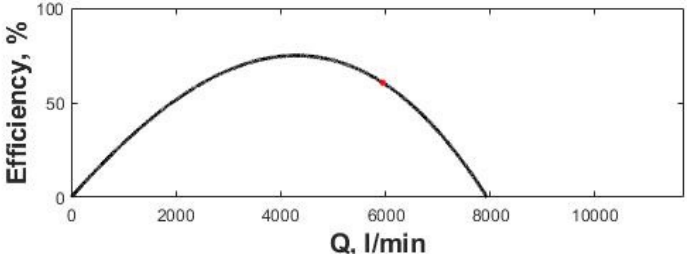
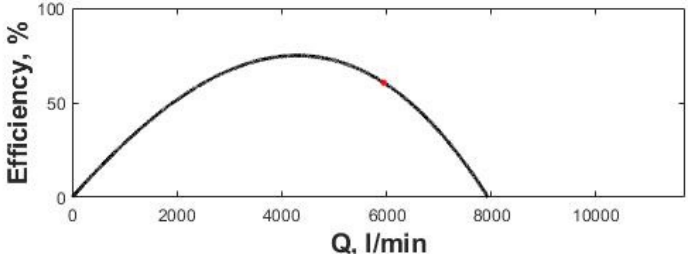
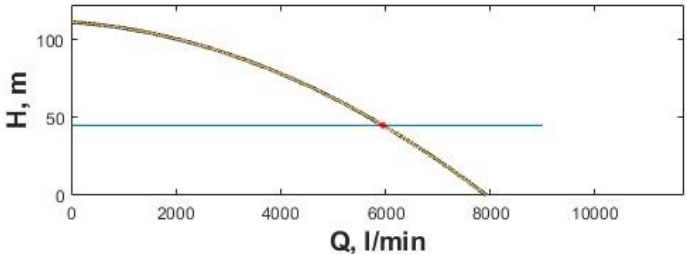
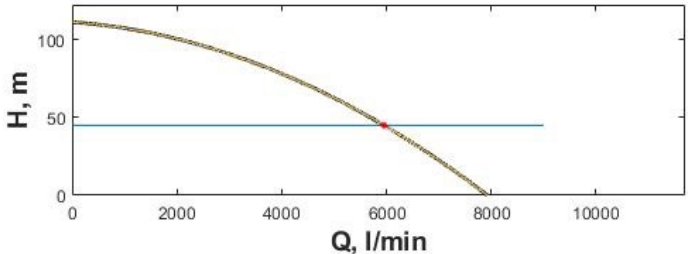


Q=5952 l/min  
H=45 m  
 $\eta=60.5\%$



$\eta = 60.5\%$

Débit demandé  
Q=11904 l/min (50%)



# CONTRÔLE DU SYSTÈME DE POMPAGE



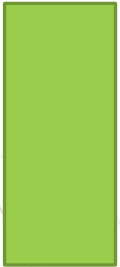
INDAR 257-3



Q=1094 l/min  
H=45 m  
 $\eta=44.4\%$



Q=5952 l/min  
H=45 m  
 $\eta=60.5\%$

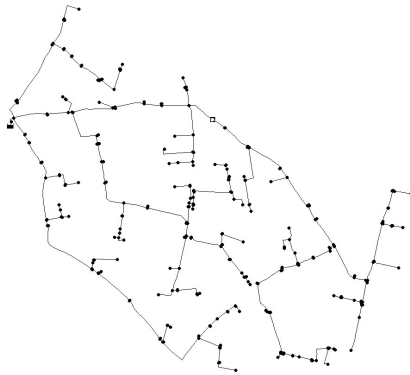
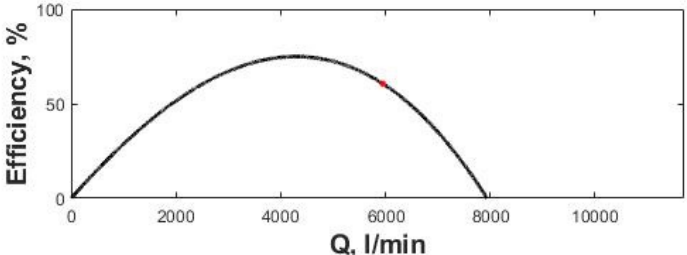
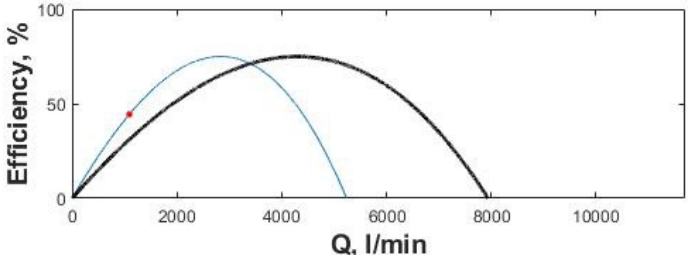
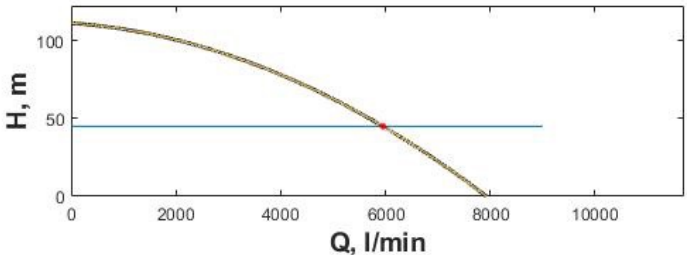
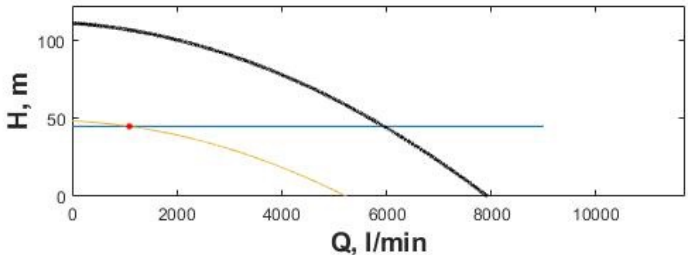


Q=5952 l/min  
H=45 m  
 $\eta=60.5\%$

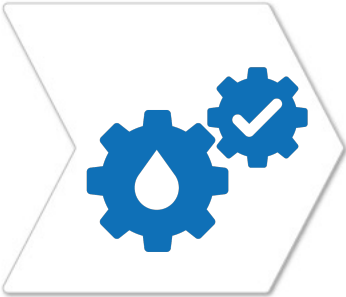


$$\eta = \frac{1094 \cdot 44.4 + (5952 \cdot 60.5) \cdot 2}{12998} = 59.1\%$$

Débit demandé  
Q=12998 l/min (55%)



# CONTRÔLE DU SYSTÈME DE POMPAGE



INDAR 257-3



Q=3054 l/min  
H=45 m  
 $\eta=74.6\%$



Q=5952 l/min  
H=45 m  
 $\eta=60.5\%$

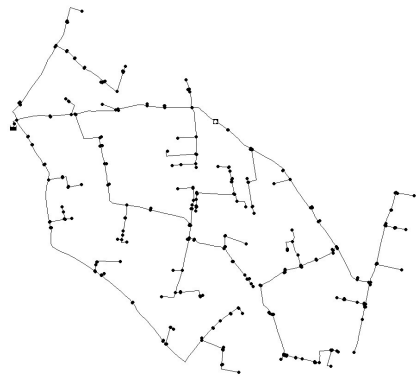
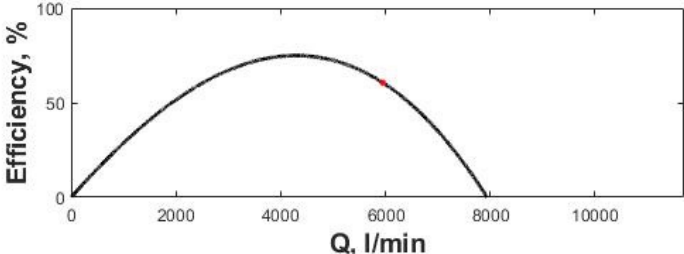
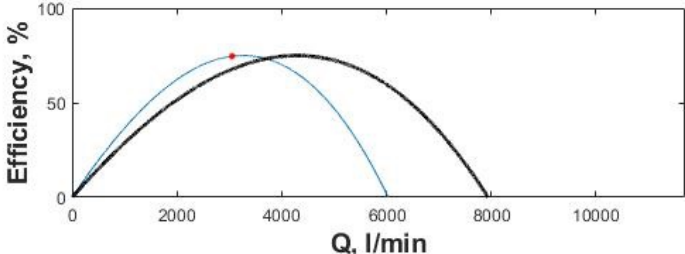
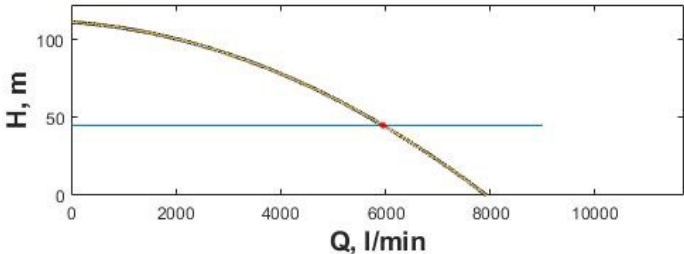
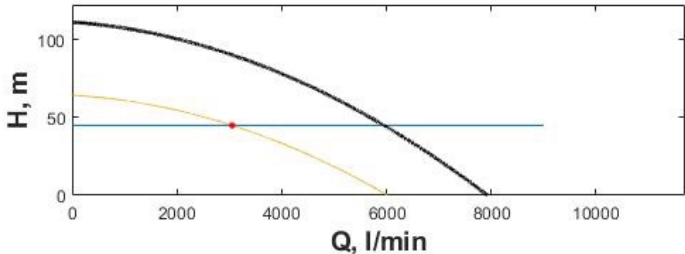


Q=5952 l/min  
H=45 m  
 $\eta=60.5\%$



$$\eta = \frac{3054 \cdot 74,6 + (5952 \cdot 60,5) \cdot 2}{14958} = 63,4\%$$

Débit demandé  
Q=14958 l/min (63%)



# CONTRÔLE DU SYSTÈME DE POMPAGE



INDAR 257-3



Q=5085 l/min  
H=45 m  
 $\eta=67.1\%$



Q=5952 l/min  
H=45 m  
 $\eta=60.5\%$

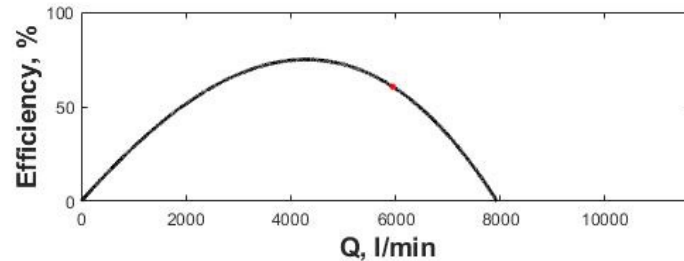
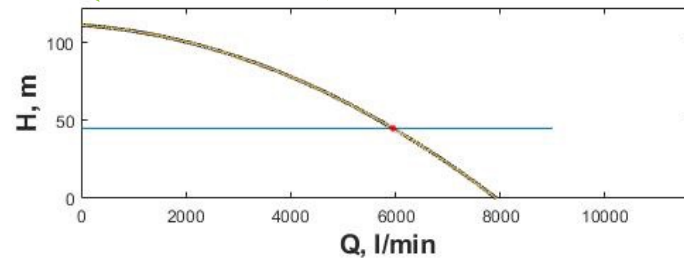
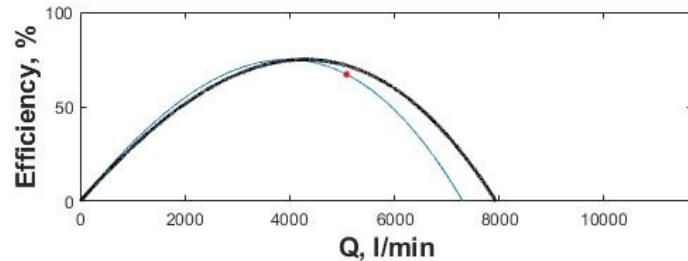
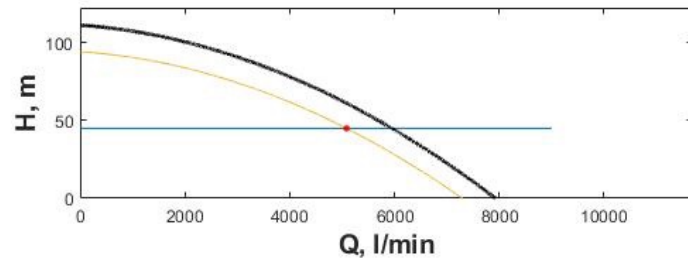
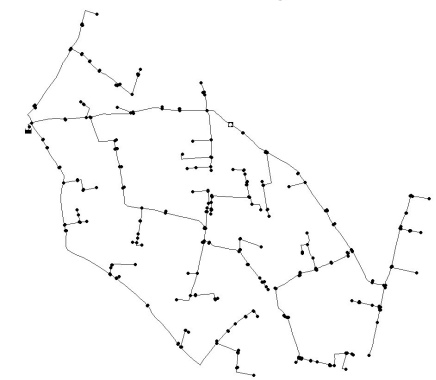


Q=5952 l/min  
H=45 m  
 $\eta=60.5\%$



$$\eta = \frac{5085 \cdot 67.1 + (5952 \cdot 60.5) \cdot 2}{16989} = 62.47\%$$

Débit demandé  
Q=16989 l/min (71%)



# CONTRÔLE DU SYSTÈME DE POMPAGE



INDAR 257-3



Q=5952 l/min  
H=45 m  
 $\eta=60.5\%$



Q=5952 l/min  
H=45 m  
 $\eta=60.5\%$

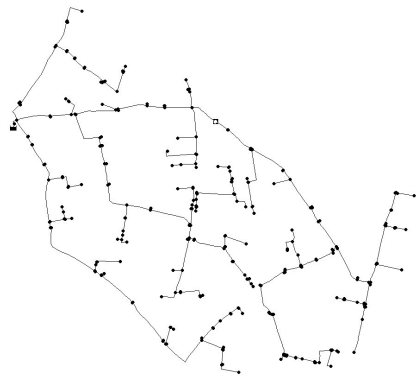
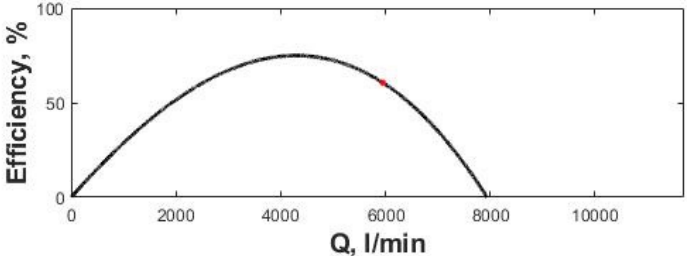
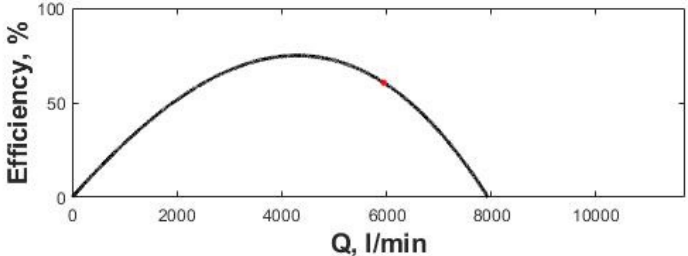
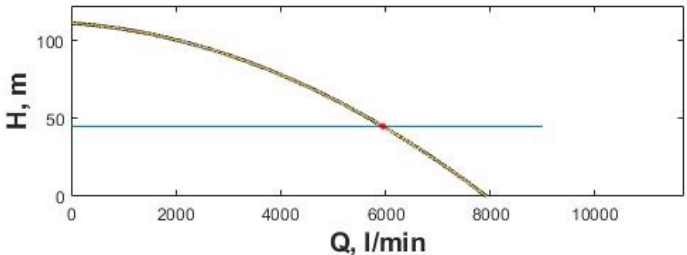
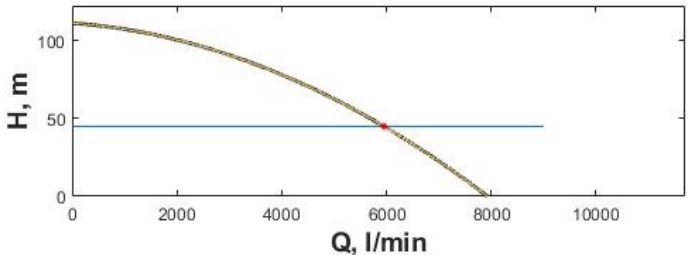


Q=5952 l/min  
H=45 m  
 $\eta=60.5\%$



$\eta = 60.5\%$

Débit demandé  
Q=17856 l/min (75%)





# CONTRÔLE DU SYSTÈME DE POMPAGE



INDAR 257-3



Q=1094 l/min  
H=45 m  
 $\eta=44.4\%$



Q=5952 l/min  
H=45 m  
 $\eta=60.5\%$



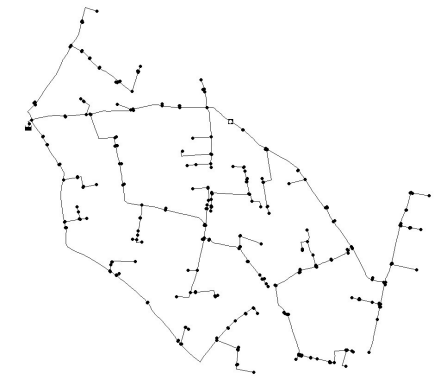
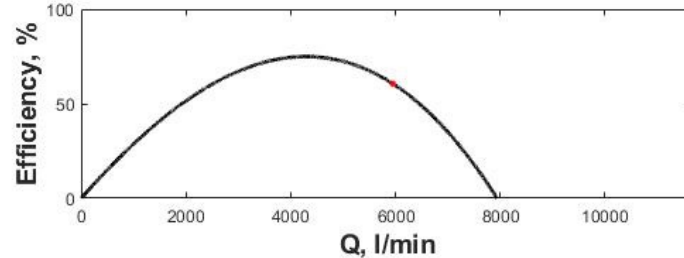
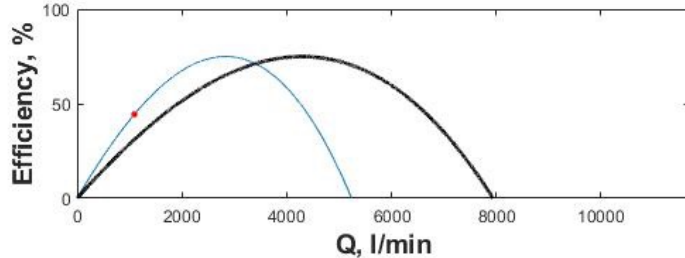
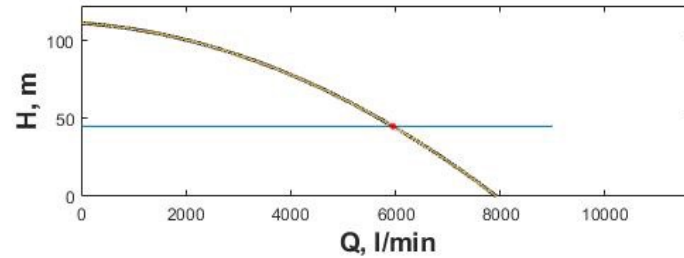
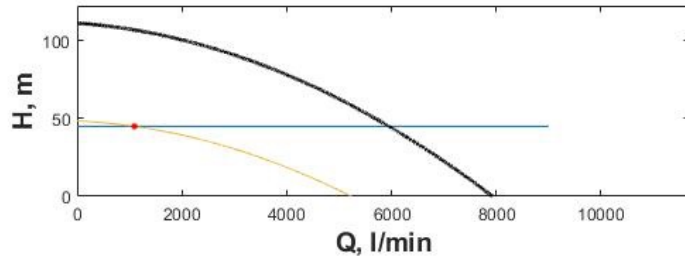
Q=5952 l/min  
H=45 m  
 $\eta=60.5\%$



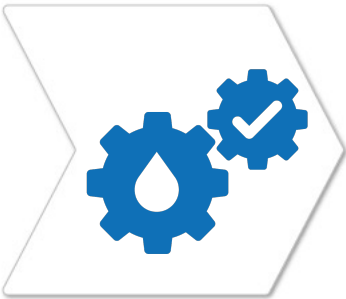
Q=5952 l/min  
H=45 m  
 $\eta=60.5\%$

$$\eta = \frac{1094 \cdot 44.4 + (5952 \cdot 60.5) \cdot 3}{18950} = 59.6\%$$

Débit demandé  
Q=18950 l/min (80%)



# CONTRÔLE DU SYSTÈME DE POMPAGE



INDAR 257-3



Q=3054 l/min  
H=45 m  
 $\eta=74.6\%$



Q=5952 l/min  
H=45 m  
 $\eta=60.5\%$

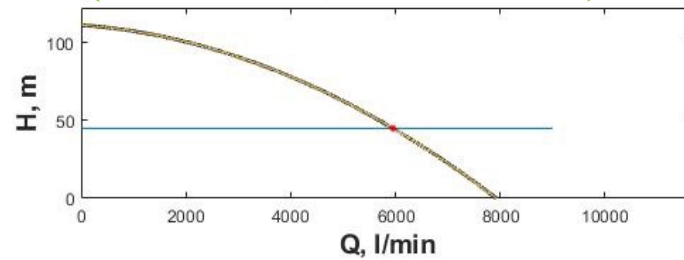
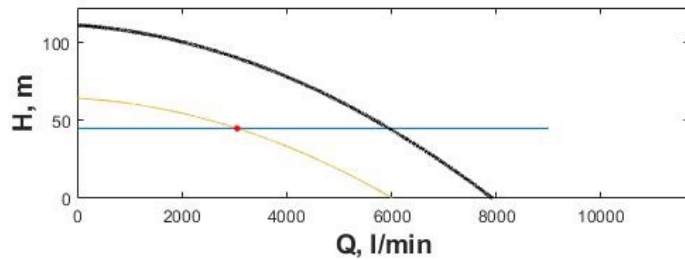


Q=5952 l/min  
H=45 m  
 $\eta=60.5\%$

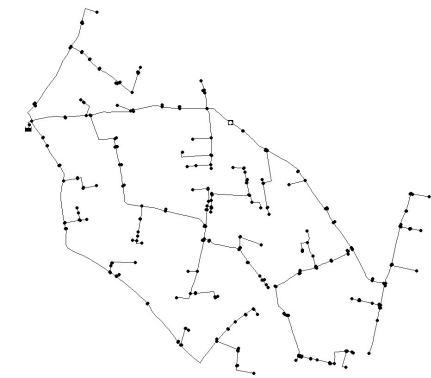
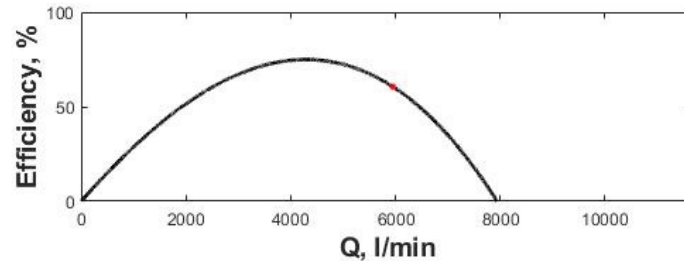
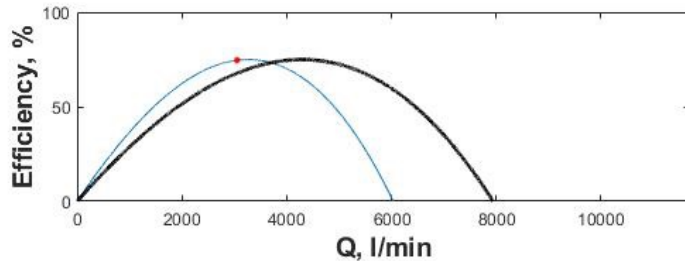


Q=5952 l/min  
H=45 m  
 $\eta=60.5\%$

$$\eta = \frac{3054 \cdot 74,6 + (5952 \cdot 60,5) \cdot 3}{20910} = 62,6\%$$



Débit demandé  
Q=20910 l/min (88%)



# CONTRÔLE DU SYSTÈME DE POMPAGE



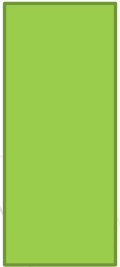
INDAR 257-3



Q=5085 l/min  
H=45 m  
 $\eta=67.1\%$



Q=5952 l/min  
H=45 m  
 $\eta=60.5\%$

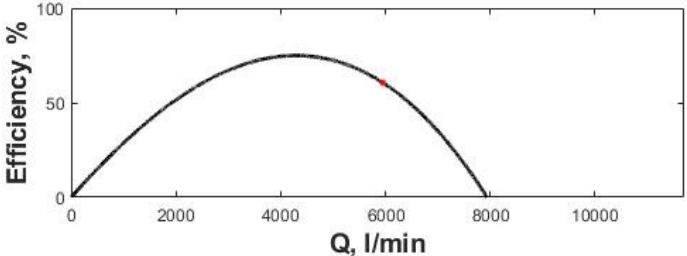
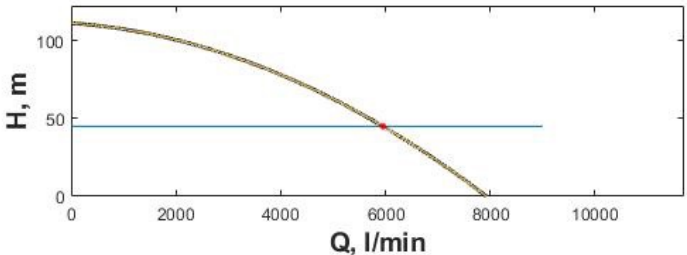
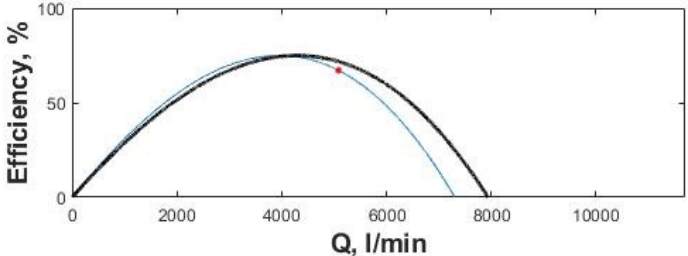
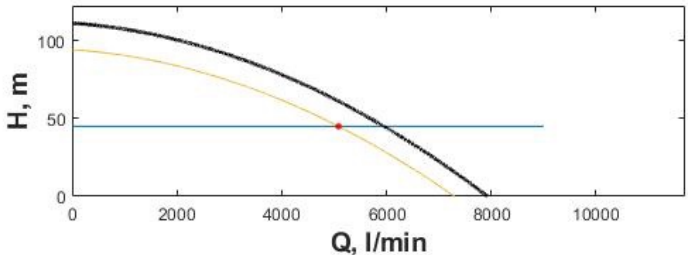


Q=5952 l/min  
H=45 m  
 $\eta=60.5\%$

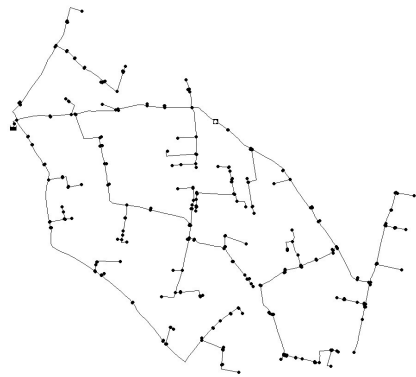


Q=5952 l/min  
H=45 m  
 $\eta=60.5\%$

$$\eta = \frac{5085 \cdot 67.1 + (5952 \cdot 60.5) \cdot 3}{22941} = 62\%$$



Débit demandé  
Q=22941 l/min (96%)



# CONTRÔLE DU SYSTÈME DE POMPAGE



INDAR 257-3



Q=5952 l/min  
H=45 m  
 $\eta=60.5\%$



Q=5952 l/min  
H=45 m  
 $\eta=60.5\%$

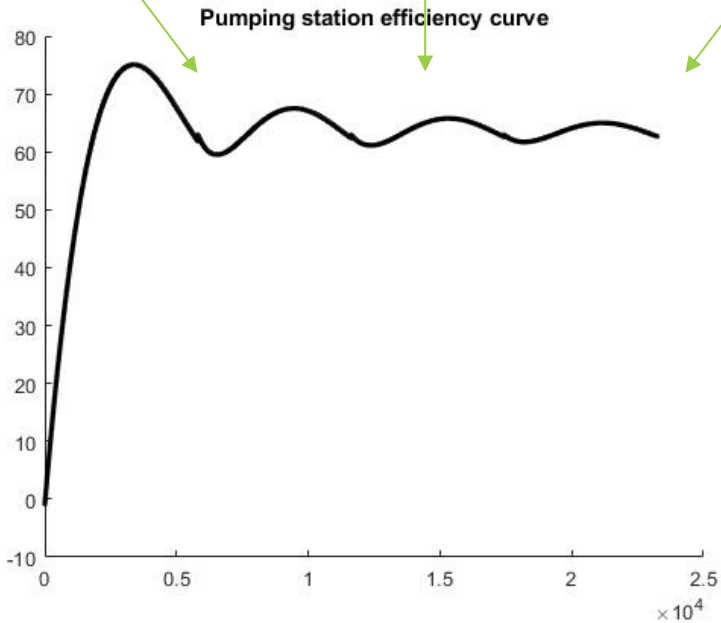


Q=5952 l/min  
H=45 m  
 $\eta=60.5\%$

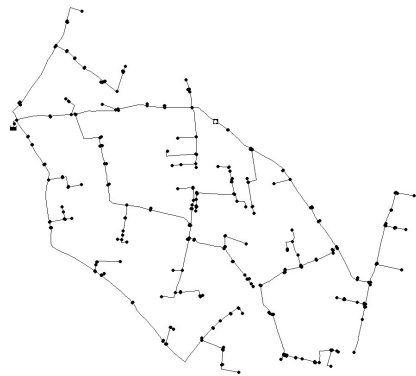


Q=5952 l/min  
H=45 m  
 $\eta=60.5\%$

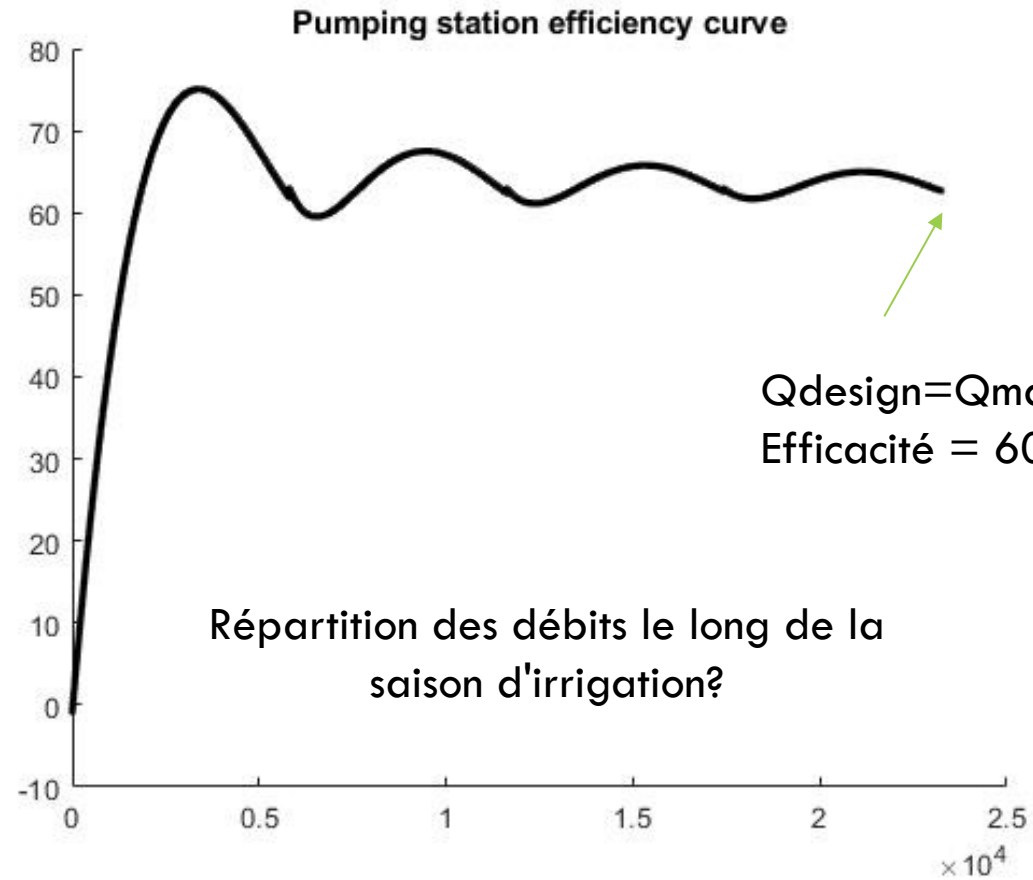
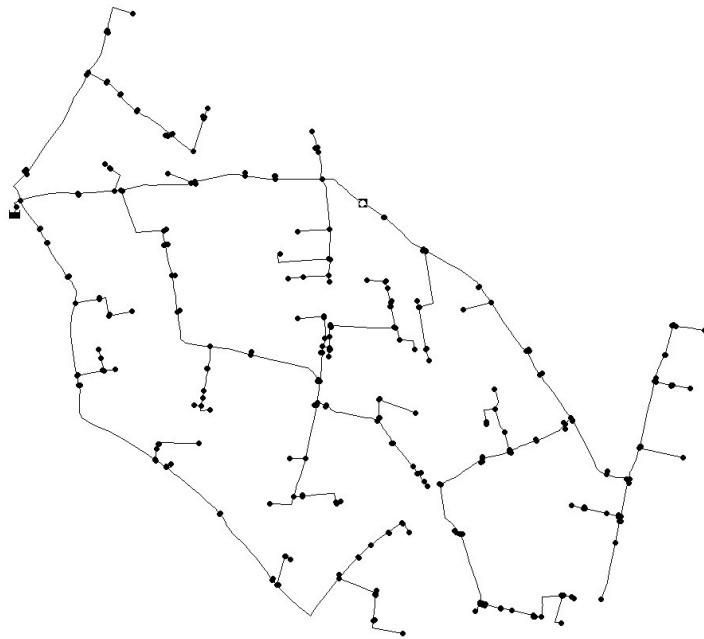
$\eta = 60.5\%$



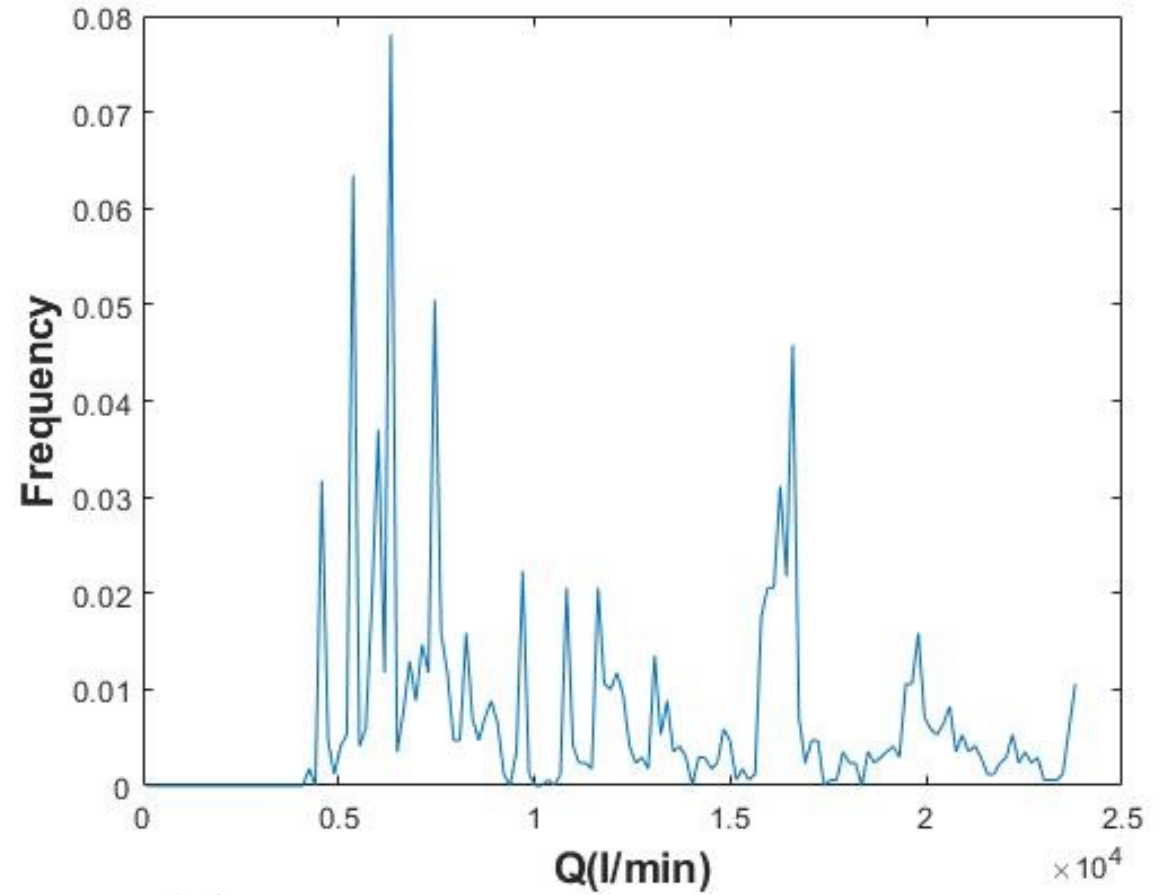
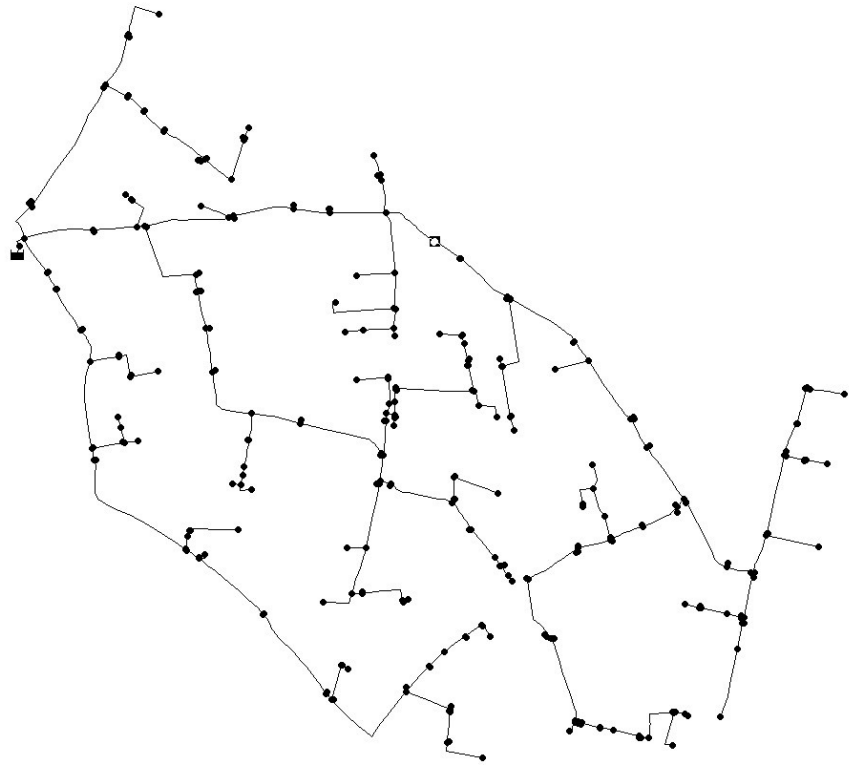
Débit demandé  
Q=23808 l/min (100%)



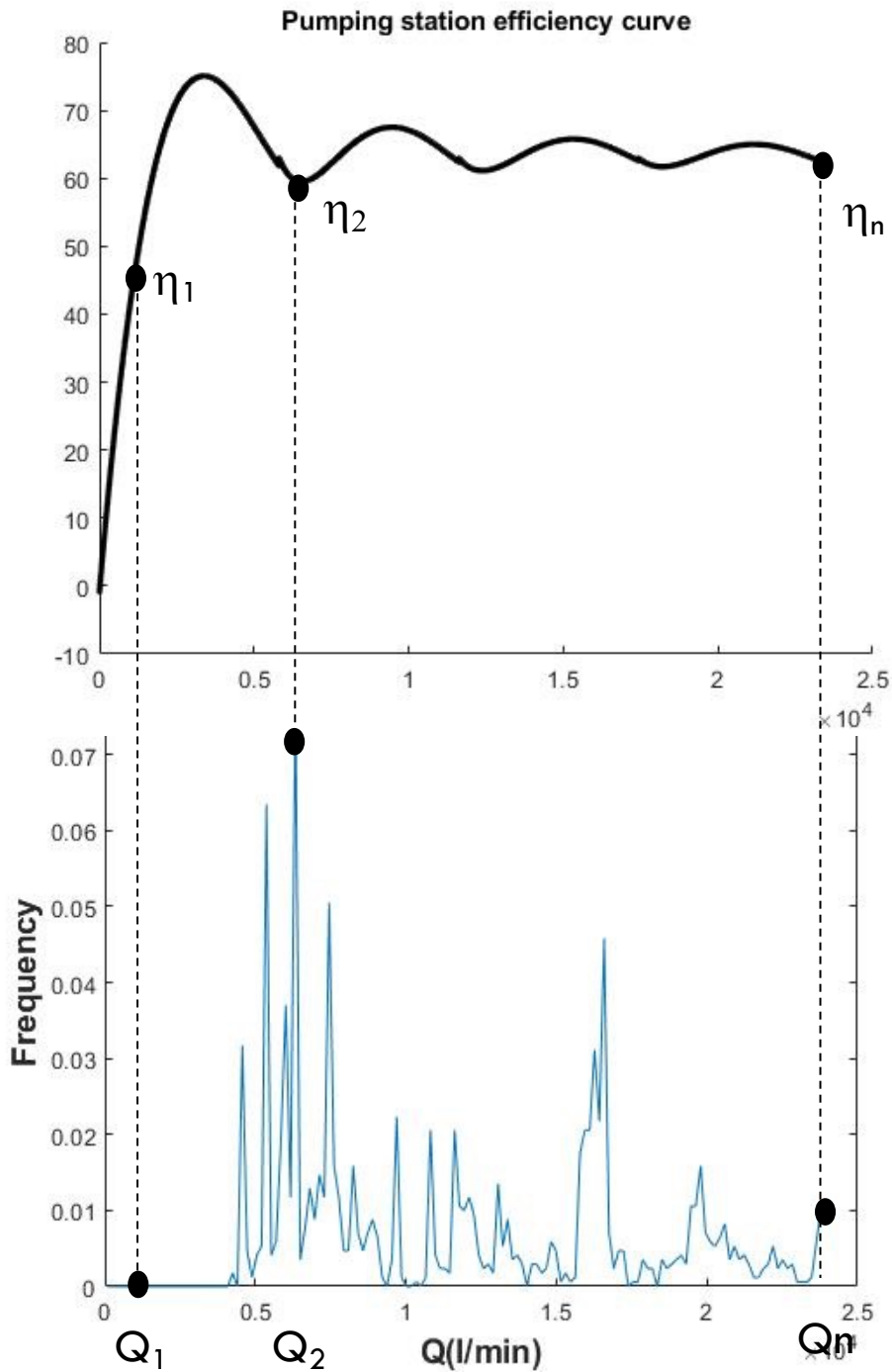
# CONTRÔLE DU SYSTÈME DE POMPAGE



# CONTRÔLE DU SYSTÈME DE POMPAGE



CO

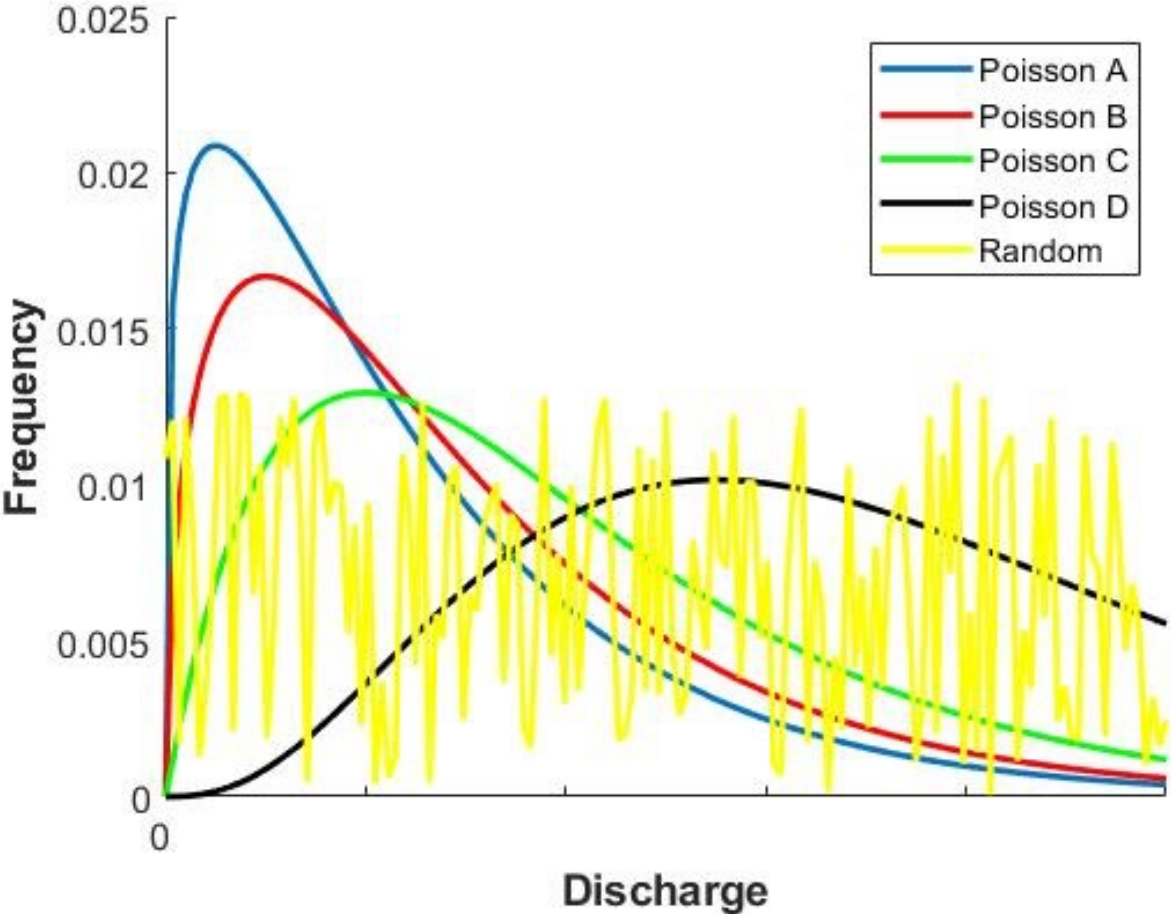


## POMPAGE



$$\eta_{moyenne} = \frac{\eta_1 \cdot Q_1 \cdot f_1 + \eta_2 \cdot Q_2 \cdot f_2 + \dots + \eta_n \cdot Q_n \cdot f_n}{Q_1 + Q_2 + \dots + Q_n}$$

# CONTRÔLE DU SYSTÈME DE POMPAGE





# CONTRÔLE DU SYSTÈME DE POMPAGE

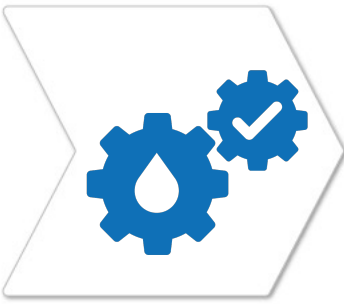
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- **Incorporer une pompe plus petite pour améliorer l'efficacité des faibles débits**
- **Incorporer une deuxième pompe à vitesse variable.**
- **Activez-le séquentiellement.**
- **Déterminez la pression de tête nécessaire. Attention au point de fonctionnement !**

# RÉCAPITULATION

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- Incorporer plusieurs pompes en série ou en parallèle, ne pas installer de très grosses pompes.
- Réglez-le avec des variateurs de vitesse. Une régulation optimale peut nécessiter l'activation séquentielle de deux d'entre eux.
- La pompe n'exige généralement pas le débit maximal. Concevez et gérez votre station de pompage en tenant compte de la fréquence de chaque débit.