



## Centrifugal Pump Analysis

You have been asked to select a centrifugal pump for cooling water service. Given the following process requirements, determine if a single stage pump, with one suction eye, operating at 1780 rpm is a reasonable design option:

Service: Cooling Water  
Pump ID number: P102  
RPM: 1780  
Flowrate: 2438 gpm  
Suction pressure: 50 psig  
Discharge pressure: 154 psig  
Specific gravity: 1.0  
Efficiency: 82%  
NPSHa: 50 ft  
NPSH margin required: 34 ft  
Number of suction eyes: 1  
Number of stages: 1

```
Head(ft)@BEP = ((DischargePressureminusSuctionPressure) * 2.31) / (SpecificGravity)
Head(ft)@BEP = ((154 - 50) * 2.31) / (1.0)
Head(ft)@BEP = (240.24) / (1.0)
Head(ft)@BEP = 240.24

Headperstage(ft) = (Head(ft)@BEP) / (Numberofstages)
Headperstage(ft) = (240.24) / (1)
Headperstage(ft) = 240.24

Ns = (RPM * (Flow@BEP-5)) / ((Headperstage(ft))-75)
Ns = (1780 * (2438-5)) / ((240.24)-75)
Ns = (87889.4715) / (61.0217)
Ns = 1440.2997

Nss = (RPM * (((Flow@BEP) / (Suctioneye))-5)) / ((NPSHa(ft)@BEP) / (NPSHsafetymargin(ft)))-75
Nss = (1780 * (2438 / 1)-5) / ((50 - 34)-75)
Nss = (87889.458) / (8)
Nss = 10986.1823

BrakeHorsepower = (Flow@BEP * Head(ft)@BEP * SpecificGravity) / (3960 * EstimatedEfficiency)
BrakeHorsepower = (2438 * 240.24 * 1.0) / (3960 * 82%)
BrakeHorsepower = (585705.12) / (3247.2)
BrakeHorsepower = 180.3724

Ns = (1840 * 1.02 * (Headperstage)-5) / RPM

ImpellerDia(inches) = (1840 * 1.02 * (Headperstage)-5) / RPM
ImpellerDia(inches) = (1840 * 1.02 * (240.24)-5) / 1780
ImpellerDia(inches) = (1840 * 1.02 * 15.4997) / 1780

ImpellerDia(inches) = 16.3426
```



$N_s=1440$ : This is an excellent specific speed value for an impeller, capable of providing an efficiency of over 80%.

$N_{ss}=10,986$ : This is a marginal value for suction specific speed. ( $N_{ss}$  values should be kept below 11,000.) You could consider decreasing the NPSHmargin slightly to reduce this value to the 8,000 to 10,000 range.

This ideal pump would have a 16.34 inch impeller and require a 180 hp driver.

**Overall, a single stage pump, with a single suction eye, operating a 1780 rpm appears to be a viable design selection for the given process conditions.**