

צ'ילר צנטריפוגלי - מהזדקרות סיבובית להופעת הנחשול



מוגש ע"י מהנדס יוני מלאכי



HOME SCREEN

SYSTEM STATUS
SAFETY SHUTDOWN - MANUAL RESTART

SYSTEM DETAILS
SAFETY STOP
HOME SCREEN

DATE 18 Jun 2011 **TIME** 9:54 AM **CONTROL SOURCE** Local

ACCESS LEVEL Service

Input % Full Load Amps: 0.0 %
 Input Power: 0 kW
 Operating Hours: 0 Hr
 Motor Run:

Chilled Liquid Temperature:
 Leaving: 44.0 °F
 Entering: 44.2 °F

Condenser Liquid Temperature:
 Leaving: 85.6 °F
 Entering: 85.7 °F

Buttons: System, Evaporator, Condenser, Compressor, Capacity Control, VSD, Setpoints, History, Print, Logout, Start, Clear Fault



תחום פעולה - High Capacities Vs. Low lift

Air-Cooled Chillers



Air-Cooled Scrolls
15-175 TR (50-615 kW)



Air-Cooled Screws
150-515 TR (525-1,805 kW)



YMC² Centrifugal, Magnetic- Drive Chiller
215-560 (755-1,970 kW)

Water-Cooled Chillers



Water-Cooled Scrolls
50-200 TR (175-630 kW)



Water-Cooled Screws
100-430 TR (350-1,510 kW)



Water-Cooled Centrifugals
215-6,000 TR (755-21,100 kW)



YK Centrifugal Chiller
250-3,000 TR (880-10,550 kW)

עיקרון הפעולה של מדחס צנטריפוגלי מתבסס על הפיכת אנרגיה קינטית לאנרגית לחץ, בניגוד למדחסים אחרים מטיפוס Positive Displacement שבהם פעולה הדחיסה מתבצעת ע"י שינוי נפח חלל הדחיסה.



YK



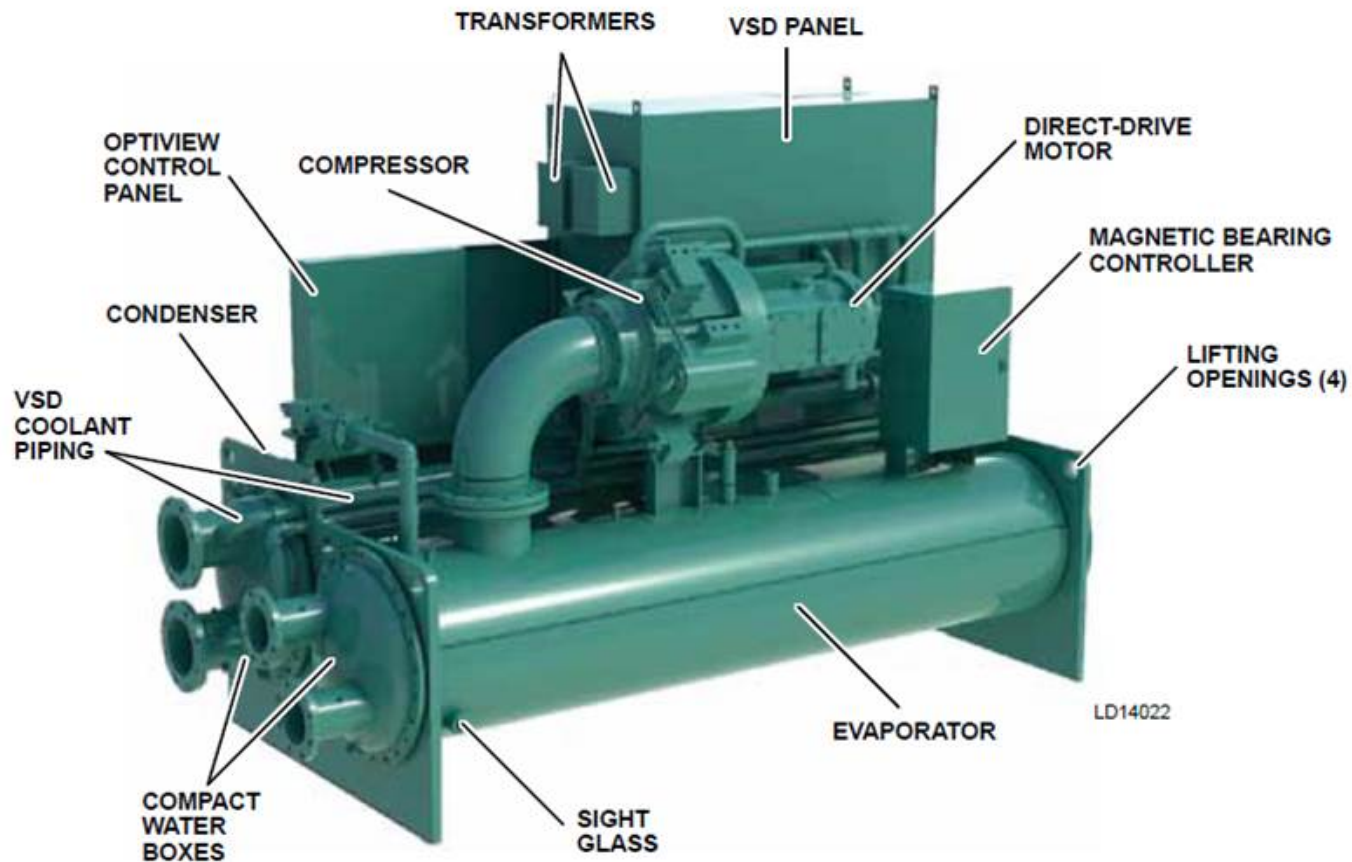
YMC²



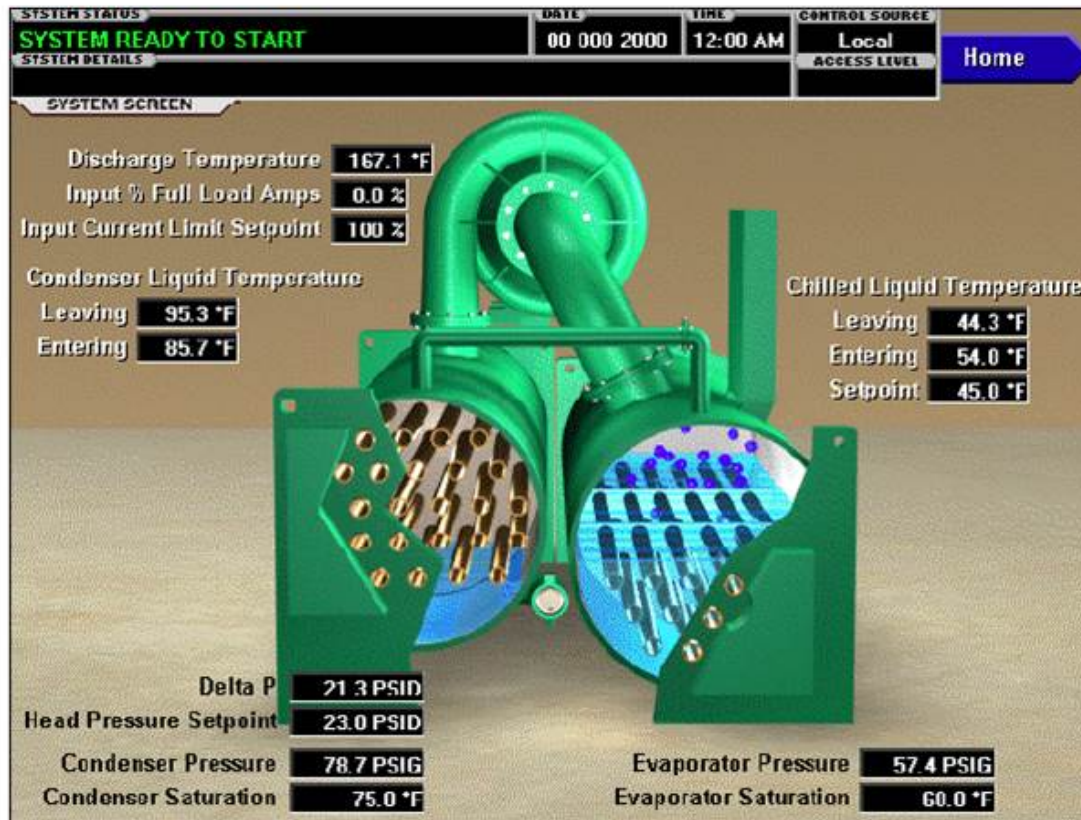
מבט מהחזית - YMC²



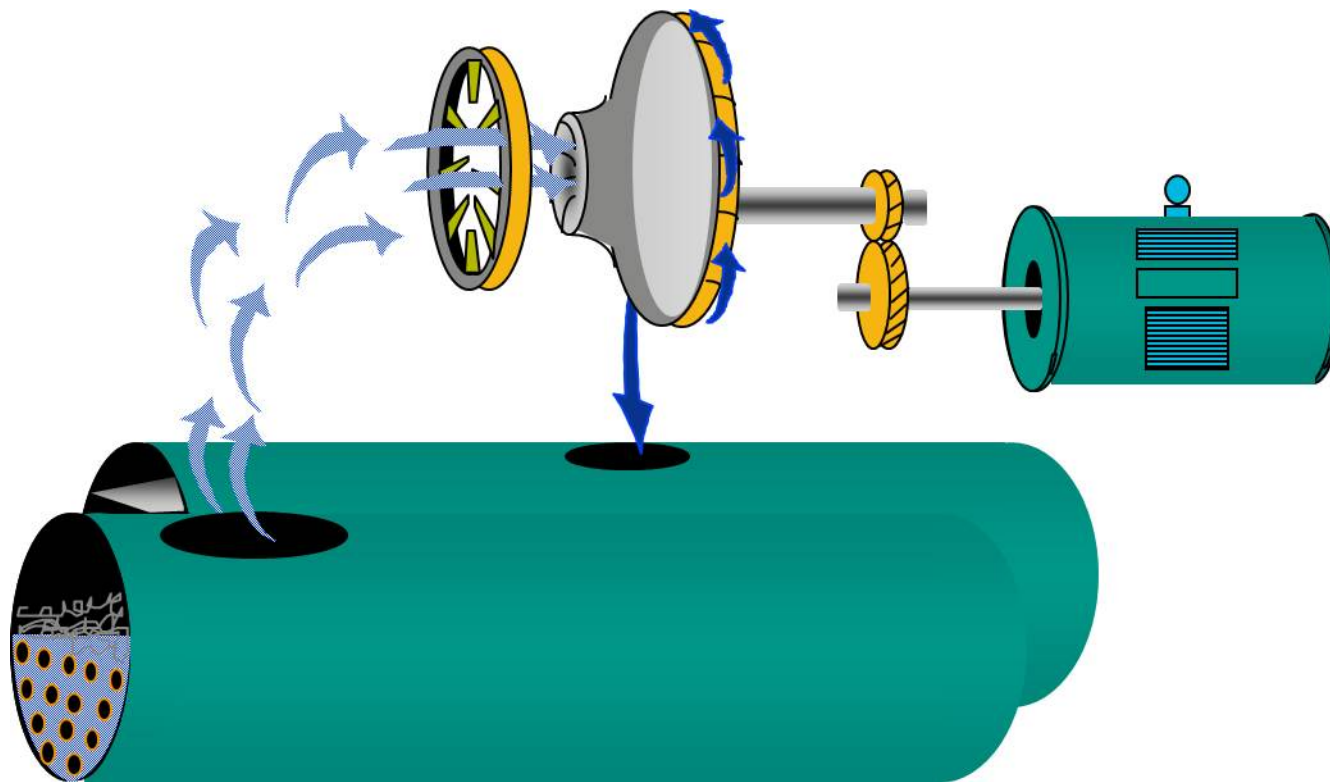
מבט מאחור - YMC²



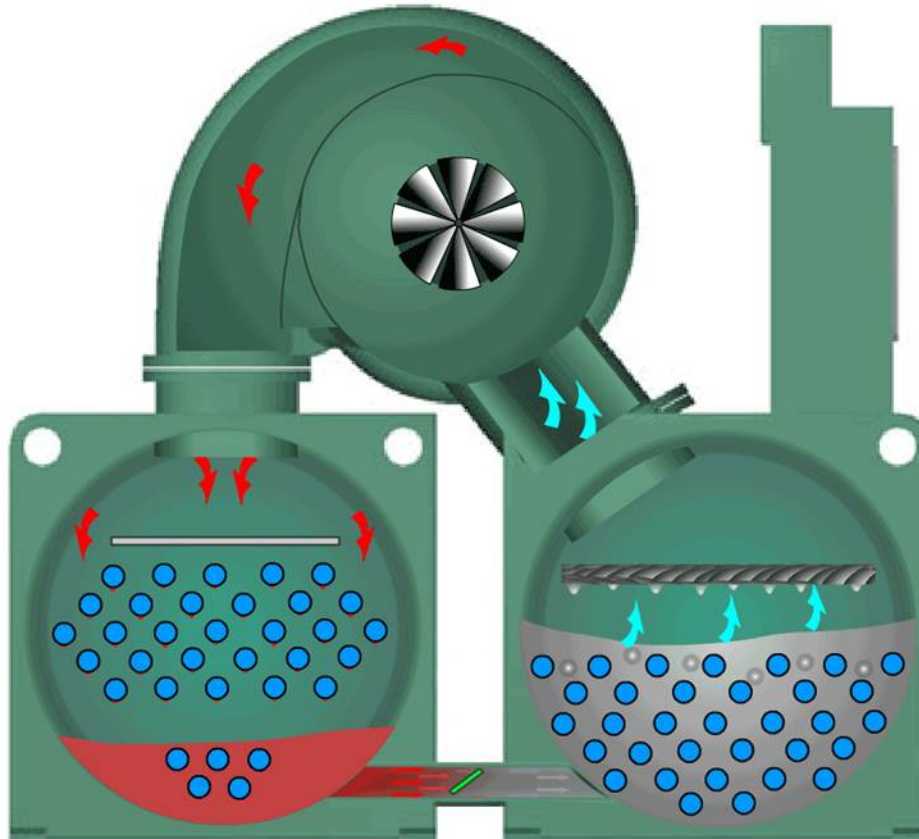
SYSTEM SCREEN



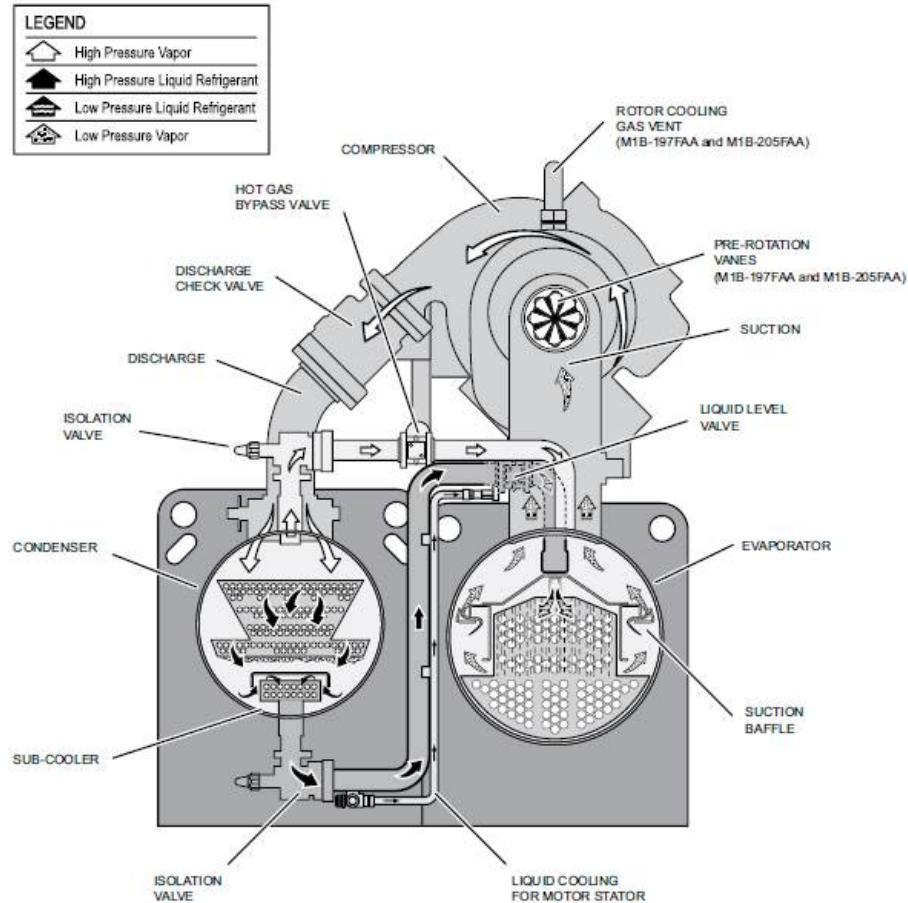
תיאור המכונה - YK



תזרים קרר - YK



תזרים קרר - YMC²



EVAPORATOR SCREEN

SYSTEM STATUS		DATE	TIME	CONTROL SOURCE		Home →
SYSTEM READY TO START		00 000 2000	12:00 AM	Local		
SYSTEM DETAILS				ACCESS USER		
EVAPORATOR SCREEN						
Leaving Chilled Liquid Temperature	44.3 °F	Leaving Chilled Liquid Temperature Setpoints				
Entering Chilled Liquid Temperature	54.0 °F	Setpoint	45.0 °F	10.0 °F	Remote Range	
Evaporator Small Temp Difference	30.6 °F	Shutdown	41.0 °F	4.0 °F	Effective Offset	
Evaporator Pressure	57.4 PSIG	Restart	45.0 °F	0.0 °F	Offset	
Evaporator Saturation Temperature	60.0 °F	Closed	Chilled Liquid Flow Switch			
Evaporator Refrigerant Temperature	13.7 °F	Stop	Chilled Liquid Pump			
						Smart Freeze Off →
Local Leaving Chilled Liquid Temperature		Leaving Chilled Liquid Temperature Cycling Offset				
Setpoint	Range	Shutdown	Restart	Refrigerant		
45.0 °F	10.0 °F	4.0 °F	0.0 °F	Enabled		

CONDENSER SCREEN

SYSTEM STATUS	DATE	TIME	CONTROL MODE
SYSTEM RUN	00 000 2000	12:50 AM	Local
SYSTEM DETAILS			Service

[Home](#)

CONDENSER SCREEN

[Refrigerant Level Control](#)

Entering Condenser Liquid Temperature	85.7 °F	
Leaving Condenser Liquid Temperature	95.3 °F	
Condenser Saturation Temperature	72.6 °F	
Condenser Small Temp Difference	-22.7 °F	30.8 °F Drop Leg Refrigerant Temp
Condenser Pressure	75.0 PSIG	41.8 °F Subcooling Temperature

[Head Pressure Control](#)

High Pressure Switch	Closed	29.9	Refrigerant Level
Condenser Liquid Flow Switch	Closed	29.9	Active Level Setpoint
Condenser Liquid Pump	Run	3.0	Level Control Valve Command

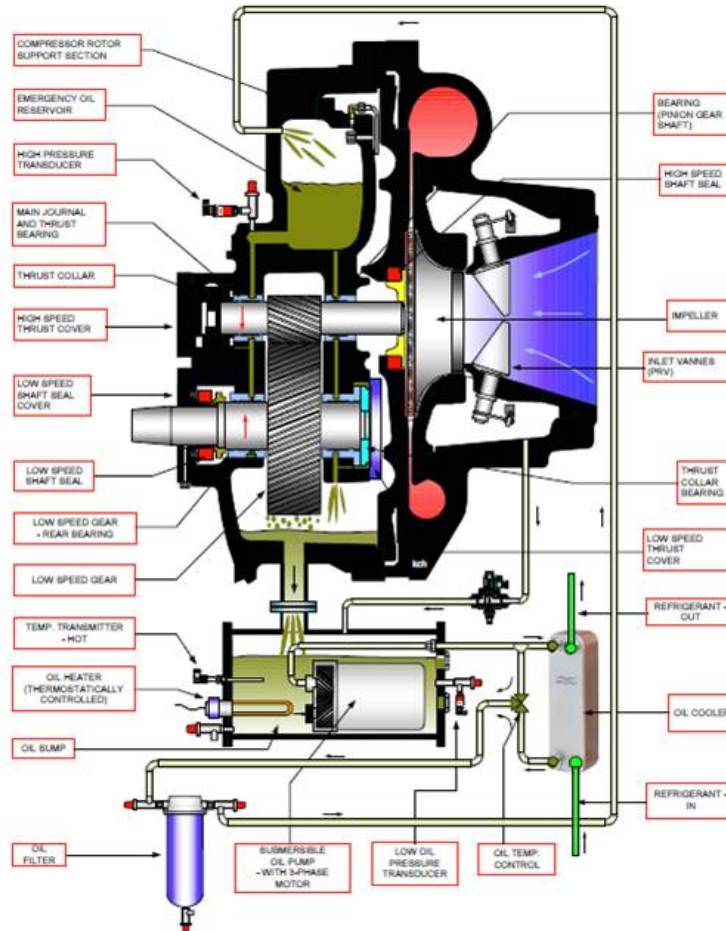
[High Pressure Warning Threshold](#) 162.5 PSIG

REFRIGERANT LEVEL CONTROL SCREEN

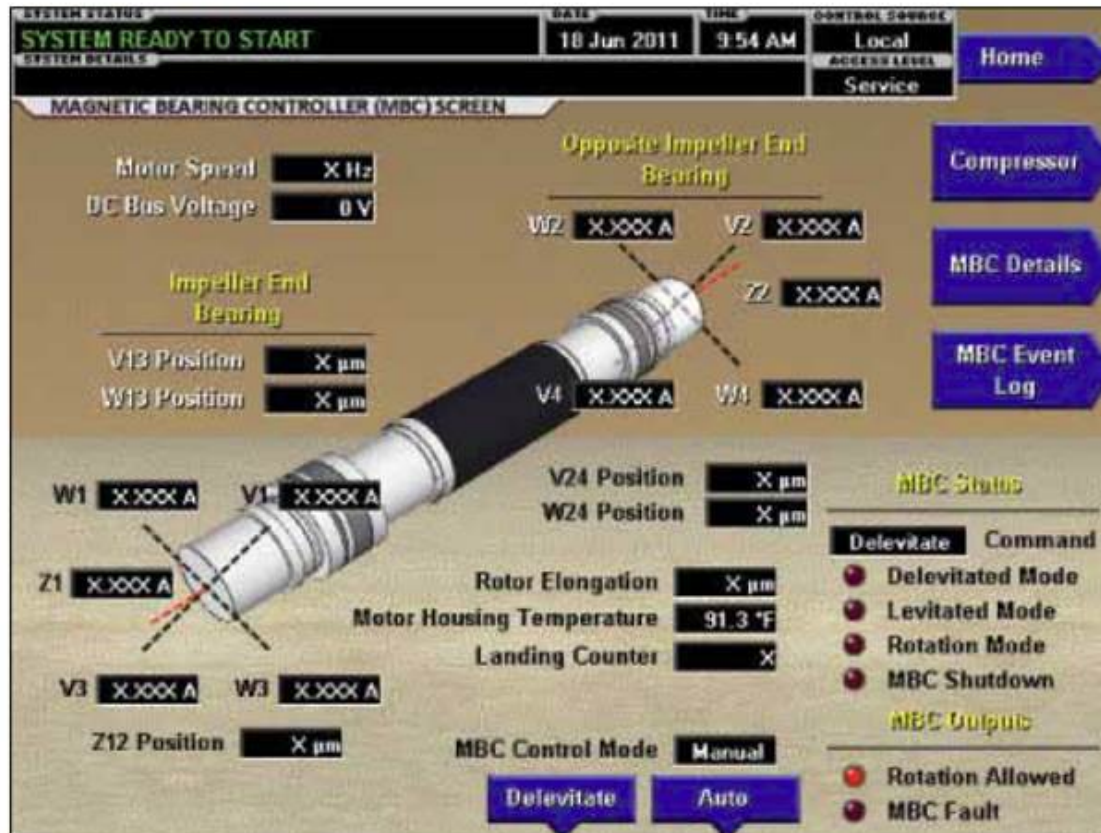


COMPRESSOR SCREEN



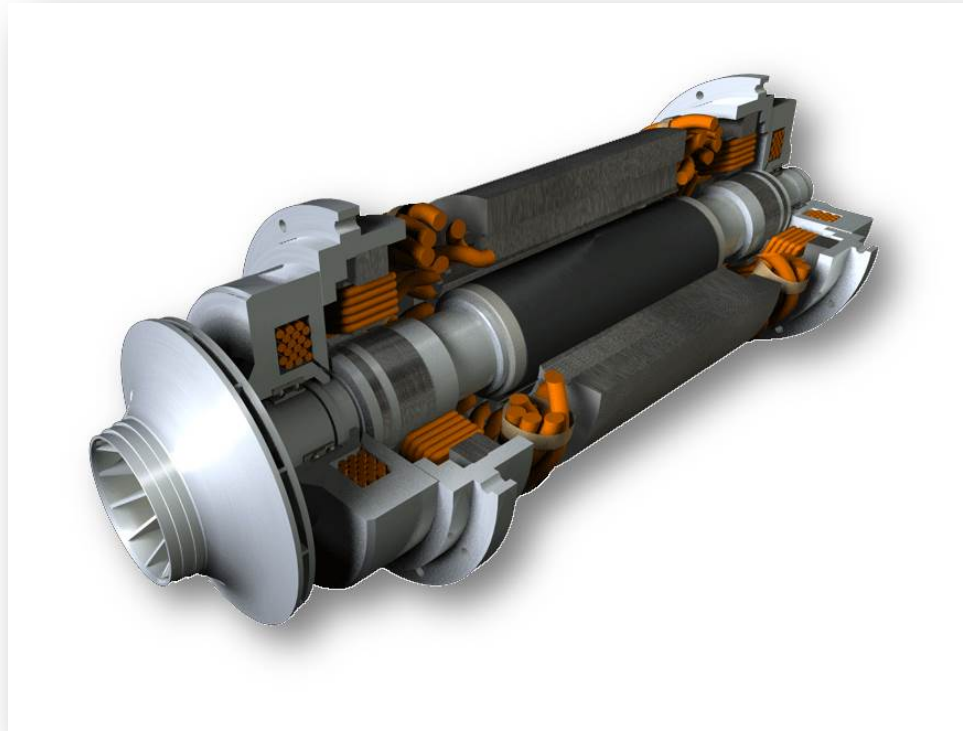


MAGNETIC BEARING CONTROLLER SCREEN

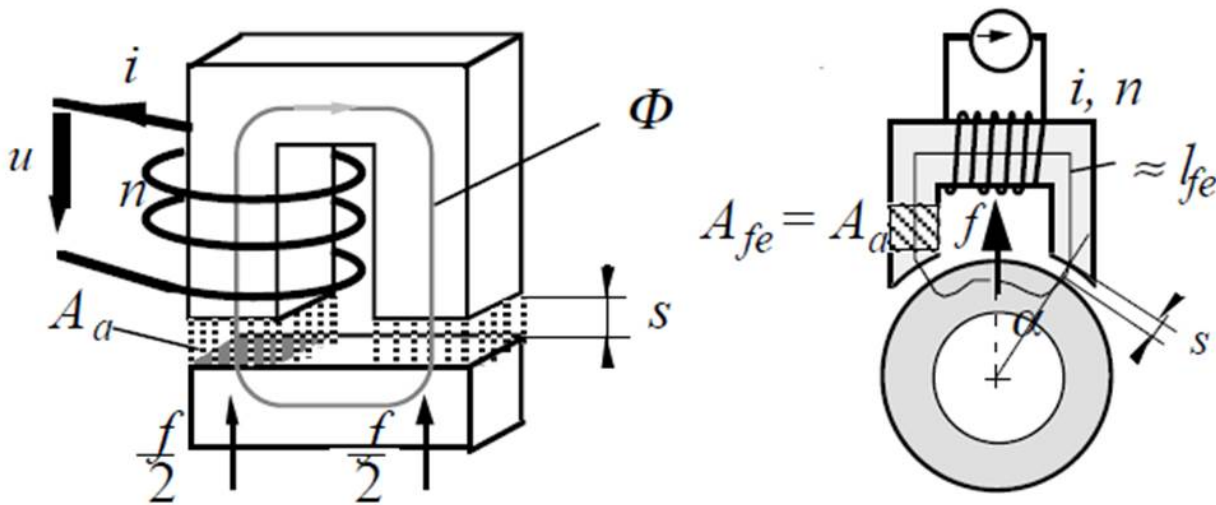




מסבים אלקטרומגנטיים - YMC²

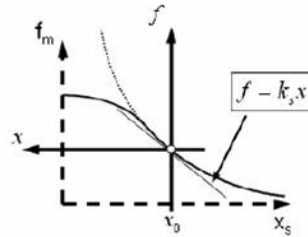


כוח משיכה בשדה אלקטרומגנטי - AMB



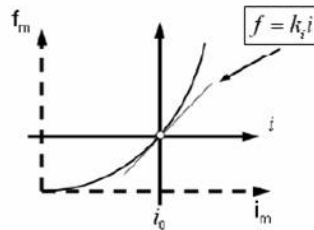
$$f = k \frac{i^2}{s^2}$$

מסבים אלקטרומגנטיים - YMC^2



Dependence of magnetic force on position.

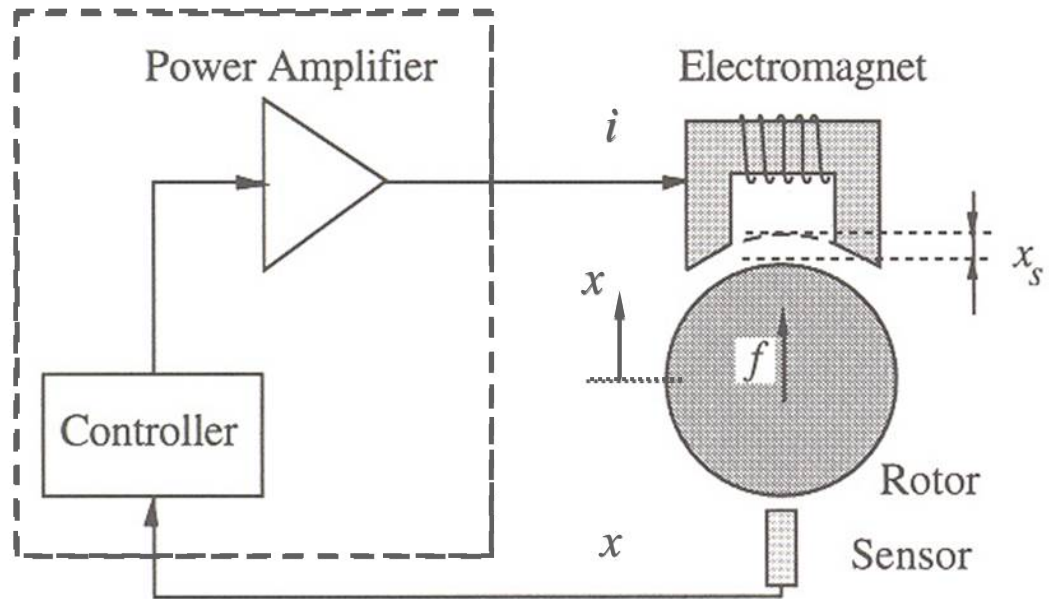
$$f(x, i) = k_s x + k_i i$$



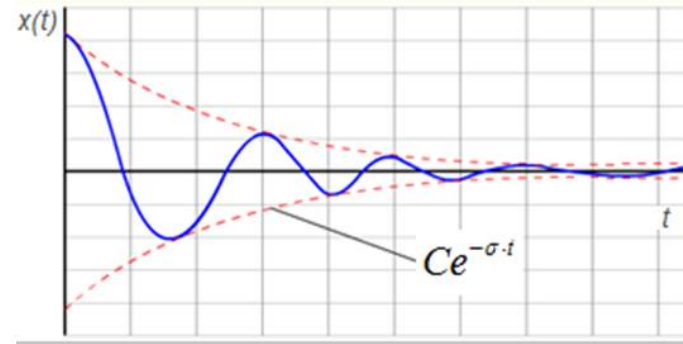
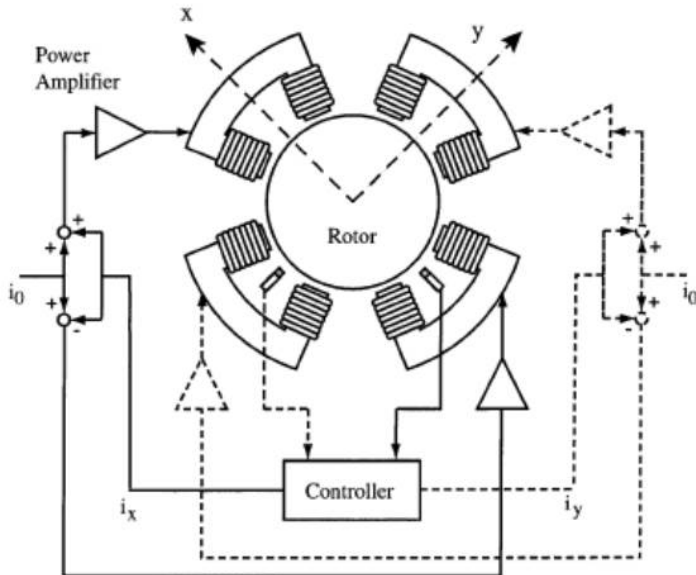
Dependence of magnetic force on current.

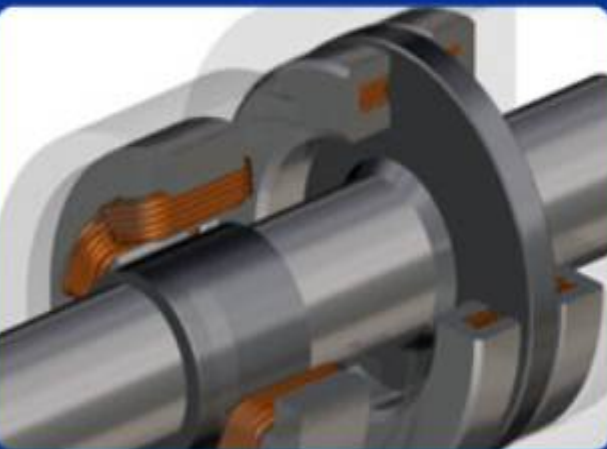
$$m\ddot{x} + d\dot{x} + kx = 0$$

מסבים אלקטרומגנטיים - YMC^2

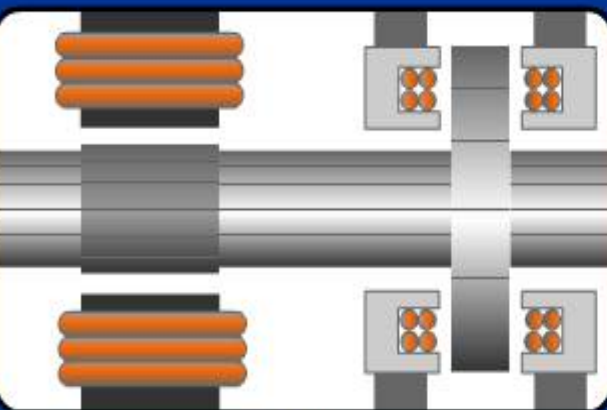


מסבים אלקטרומגנטיים - YMC^2





Active Magnetic Bearings Technology



[zoom +](#)

Action of radial and axial bearings

■ With your mouse, roll-over this animated sketch to see: the **attraction** (*top, bottom*) of radial electromagnets and the **attraction** (*left, right*) of the axial electromagnets.

■ In practice, these attractions are balanced in order to maintain a gap between the shaft (rotor) and static parts (stator). This is made by current modulations as shown in the next sketch

Principle of the radial bearing

MOTOR DETAILS SCREEN



CAPACITY CONTROLS SCREEN



SYSTEM RUN | 18 Jun 2011 | 9:54 AM | Local | Home

LEAVING CHILLED LIQUID CONTROL | Service

CAPACITY CONTROL SCREEN

Override Control		Temperature Control	
Evaporator Pressure	50.9 PSIG	Entering Chilled Liquid	54.0 °F
Override Threshold	27.0 PSIG	Leaving Chilled Liquid	44.0 °F
Condenser Pressure	78.7 PSIG	Active (LCLL) Setpoint	44.0 °F
Override Threshold	162.5 PSIG	Delta T	0.0 °F
Input Current % FLA	99.9 %	Control State	Temperature Control
Override Threshold	100.0 %	Load Limit	None
Motor Current % FLA	59.4 %	Head Pressure	27.7 PSID
Override Threshold	100.0 %	Entering Condenser Liquid	85.7 °F

Capacity Control Output Devices:

Active Output	Command	Feedback	Active Min	Control Mode
VSD	205.52 Hz	205.52 Hz	177.62 Hz	Auto
PRV	100.0 %	100.0 %	0.0 %	Manual
HGBP	0.0 %			Auto

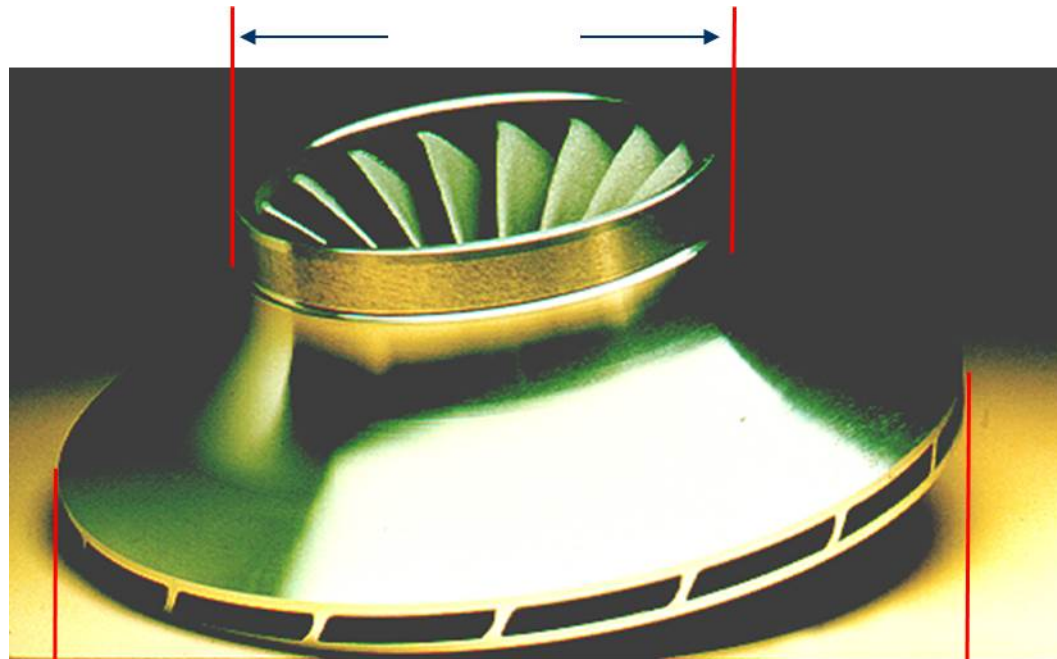
Manual Control - PRV

Manual Increment: 1.0 % | Increase | Decrease | Set | Auto

Compressor | VSD | Setpoints | Select VSD Control | Select PRV Control | Select HGBP Control

Tip Speed = מהירות היקפית = $\pi \times D \times \text{RPM}$

Impeller capacity varies as the eye diameter



Impeller lift varies as the tip diameter

That's the reason why Centrifugal chillers have *fixed* lift.

PRE-ROTATION VANES CALIBRATION SCREEN

SYSTEM STATUS: **SYSTEM READY TO START**

DATE: 09 Dec 2010 TIME: 4:31 PM CONTROL LEVEL: Local

ADJUST LEVEL: Service

Home

PRE-ROTATION VANES CALIBRATION SCREEN

- PRV Opening
- PRV Closing

0.39 V PRV Feedback Voltage

Compressor

Calibration in Progress

Auto PRV Actuator Mode

Open Close Hold Auto Start Calibration

VARIABLE SPEED DRIVE (VSD) DETAILS SCREEN

SYSTEM STATUS
SYSTEM RUN

DATE 18 Jun 2011 **TIME** 9:54 AM **CONTROL SOURCE** Local

ACCESS LEVEL Service **Home**

LEAVING CHILLED LIQUID CONTROL

VARIABLE SPEED DRIVE (VSD) DETAILS SCREEN

VSD Command Run 525 A Output Current Rating **VSD**

VSD Control State Run ABC Phase Rotation

VSD Inverter State Run

VSD Output Frequency 0.00 Hz

Motor Run Input Current Limit

DC Bus Regulating Cooling System

Precharge Complete Precharge Active

	L1	L2	L3	
Input Voltage (Peak)	0 V	0 V	0 V	0 V DC Bus Voltage
Input Voltage (RMS)	0 V	0 V	0 V	0 kVA Input kVA
Input Current (RMS)	0 A	0 A	0 A	

Phase A Phase B Phase C

Output Voltage (RMS)	0 V	0 V	0 V
Output Current (RMS)	0 A	0 A	0 A
Rectifier Baseplate Temperature	32 °F	32 °F	32 °F
Inverter Baseplate Temperature	32 °F	32 °F	32 °F

1 2

Internal Ambient Temperature	32 °F	32 °F
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Test Mode Disabled

Manual DC Bus Disabled

Manual Cooling Disabled



ביצועים לפי תקן - AHRI 550/590

$$\text{IPLV} = 0.01A + 0.42B + 0.45C + 0.12D$$

A = EER @ 100% load (44°F ELWT, 85°F CEWT)

B = EER @ 75% load (44°F ELWT, 75°F CEWT)

C = EER @ 50% load (44°F ELWT, 65°F CEWT)

D = EER @ 25% load (44°F ELWT, 65°F CEWT)

Evaporator Flow- 2.4 GPM/TR @ FF= 0.000250

Condenser Flow- 3.0 GPM/TR @ FF= 0.000100

SURGE SCREEN

SYSTEM STATUS	DATE	TIME	CONTROL SOURCE
SYSTEM RUN	10 Jun 2010	9 54 AM	Local
SYSTEM DETAILS			Service

LEAVING CHILLED LIQUID CONTROL
SURGE PROTECTION SCREEN

1.48 Delta P / P
3 Min Surge Window Time
0 Surge Window Count

Surge Detected

0 Surge Count

Compressor

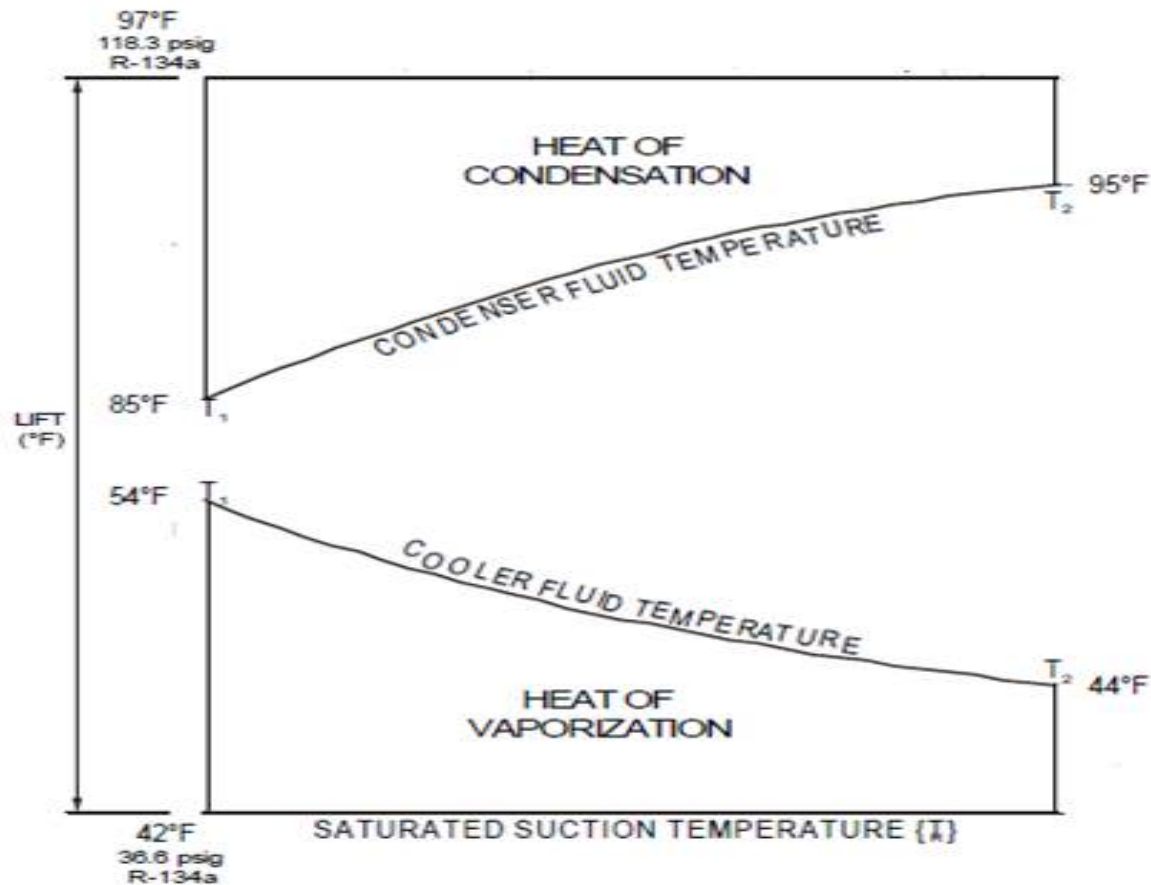
Shutdown Enabled

Count Window 3 Min

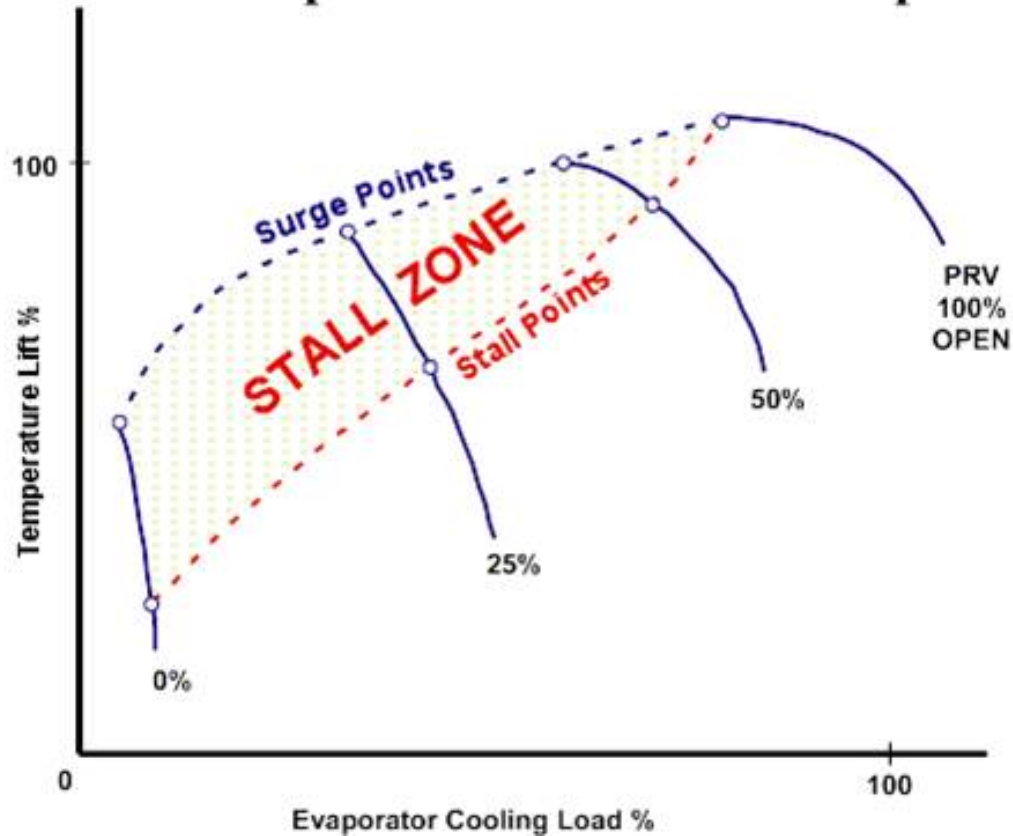
Count Limit 15

Surge Sensitivity 0.3

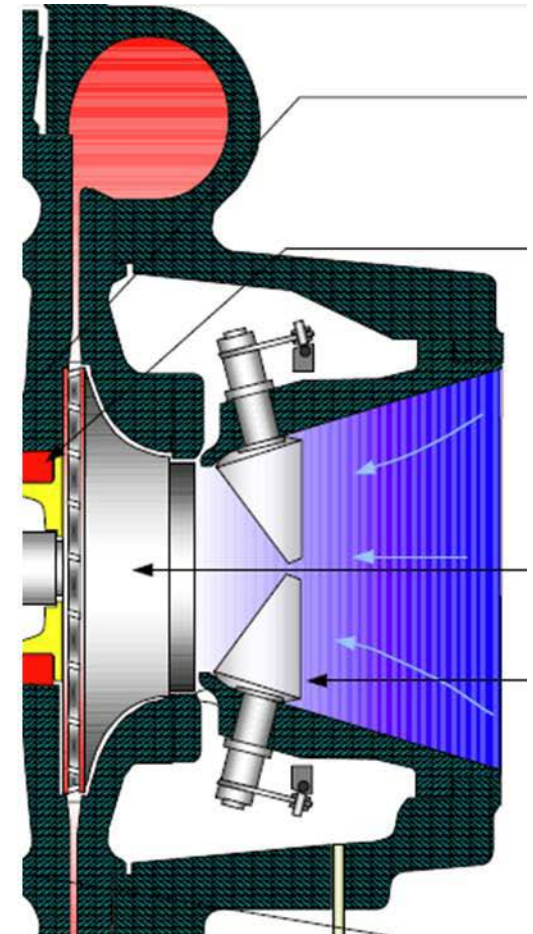
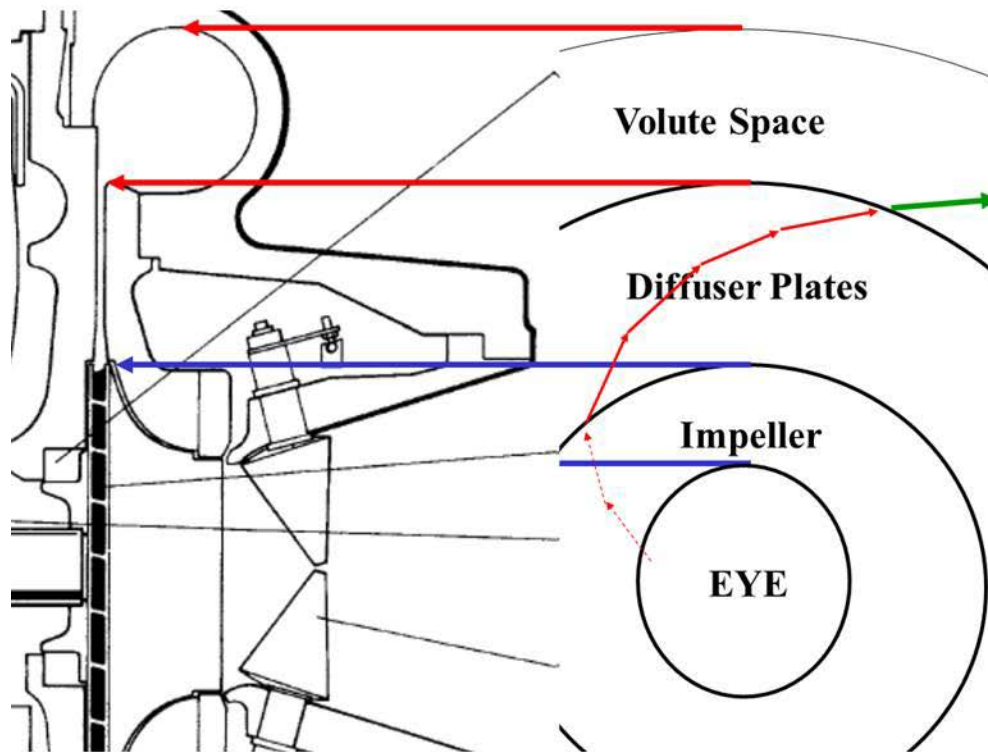
מהזדקרות סיבובית להופעת הנחשול



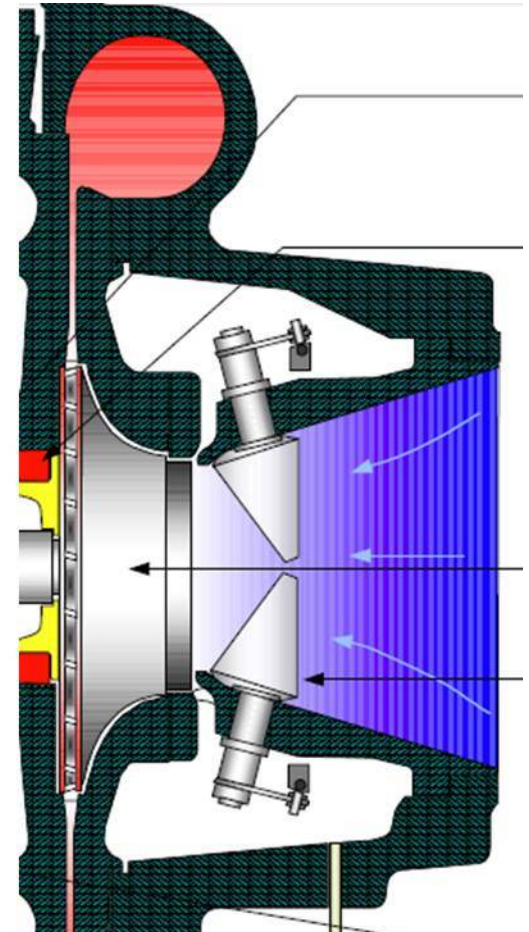
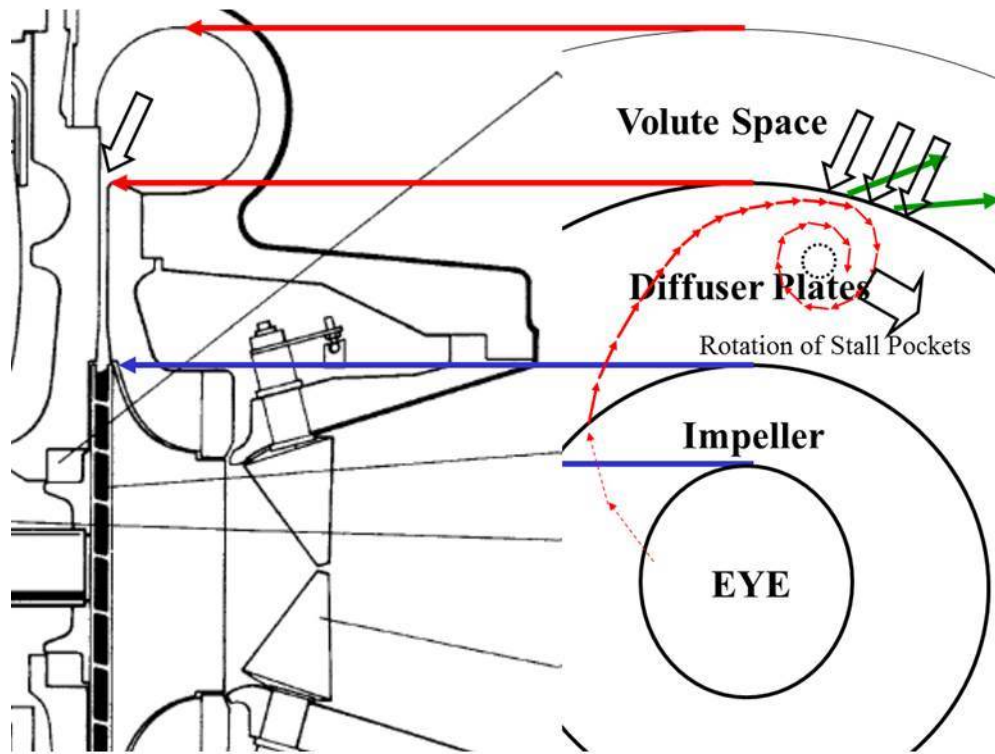
Compressor Performance Map



מהדקרות סיבובית להופעת הנחשול



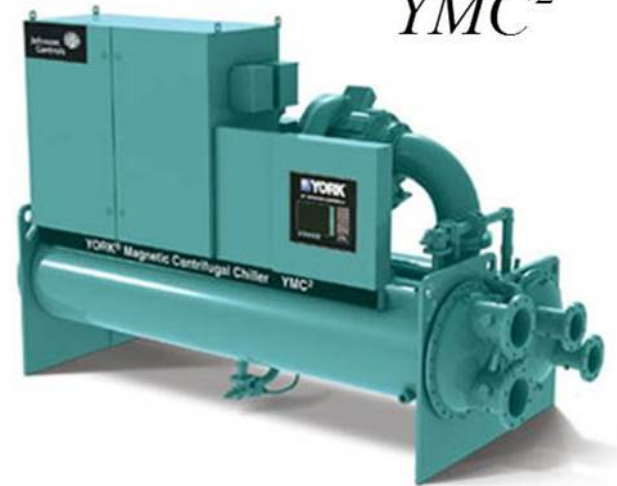
מהדקרות סיבובית להופעת הנחשול

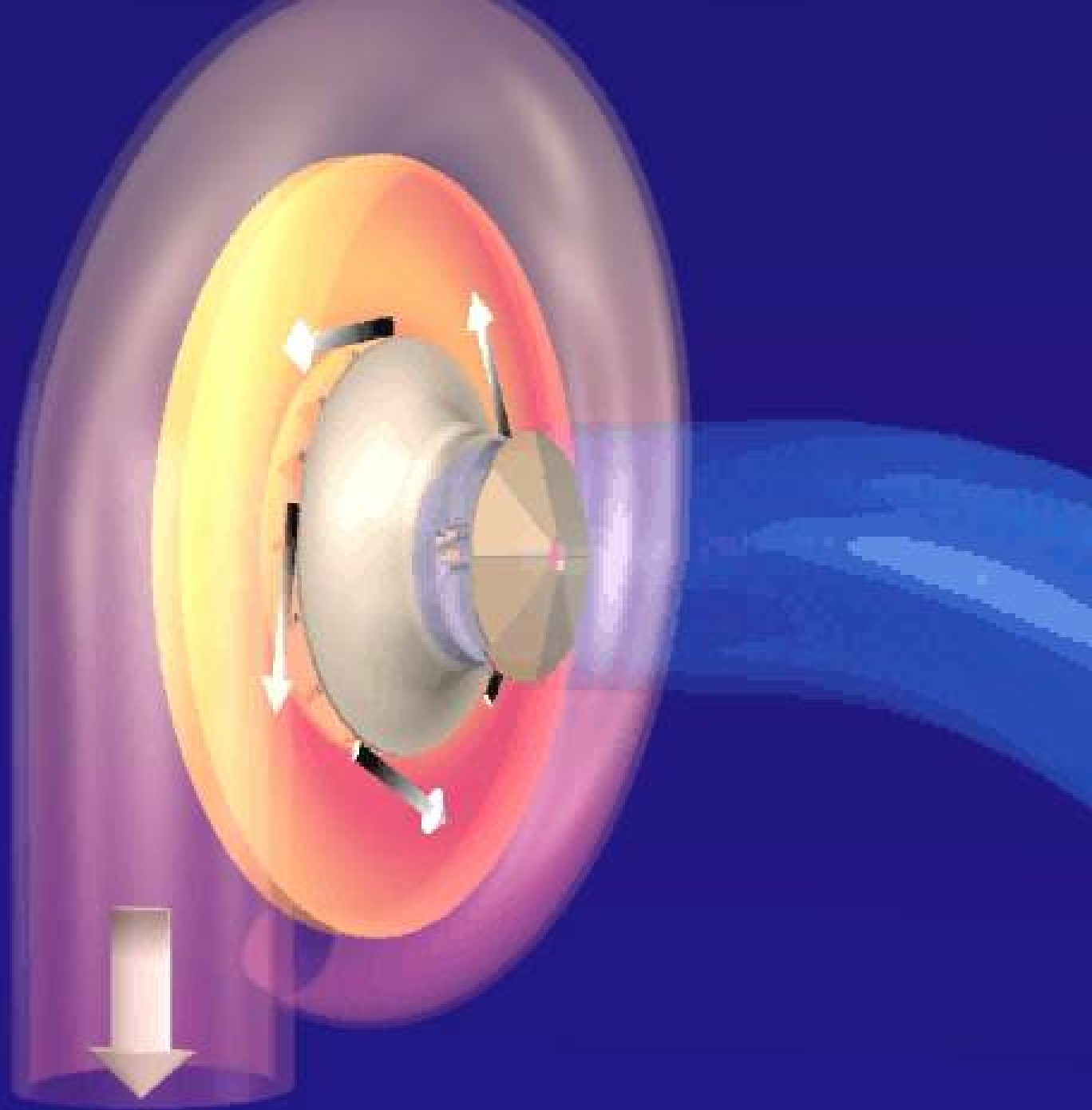


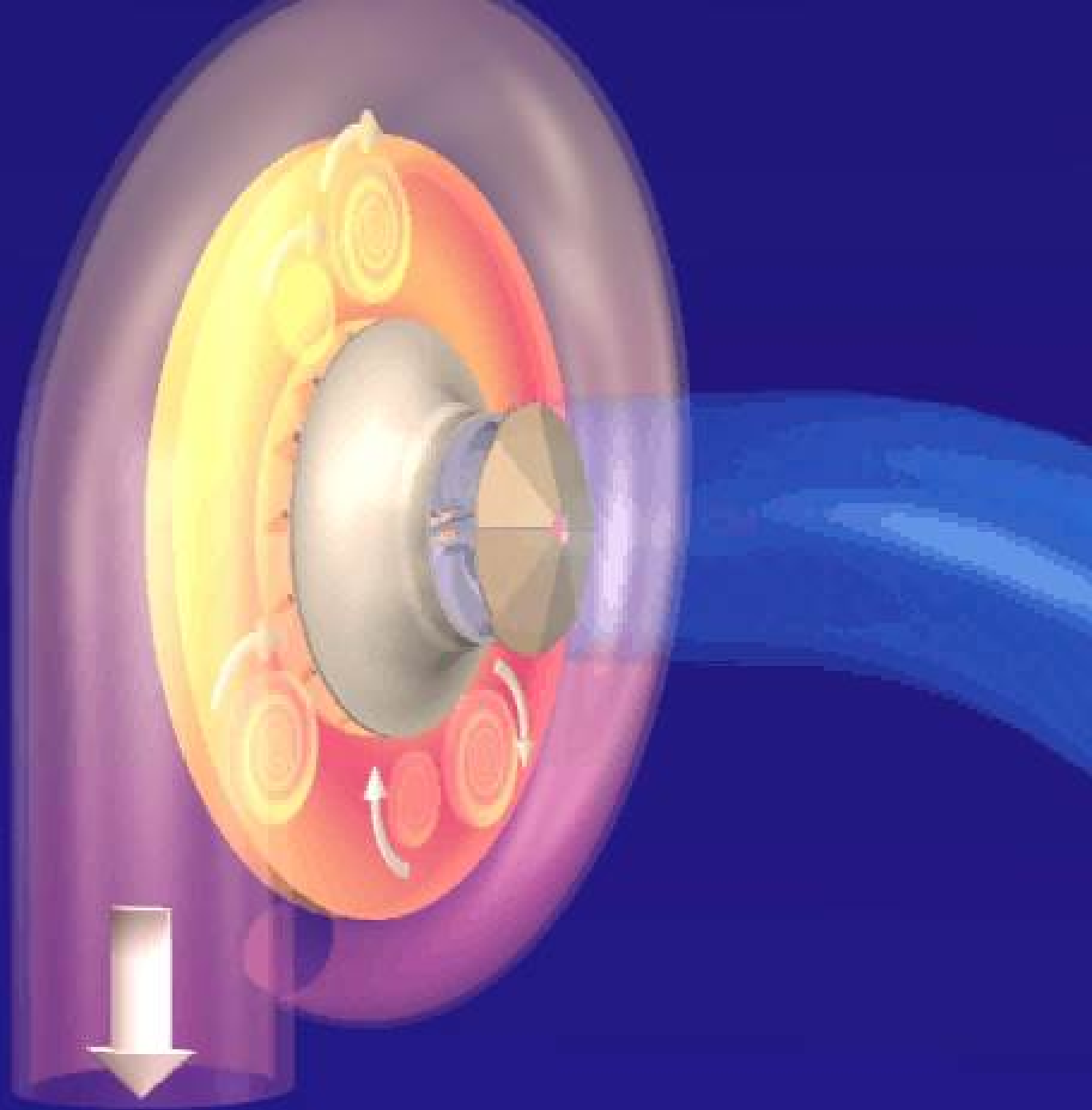
YK

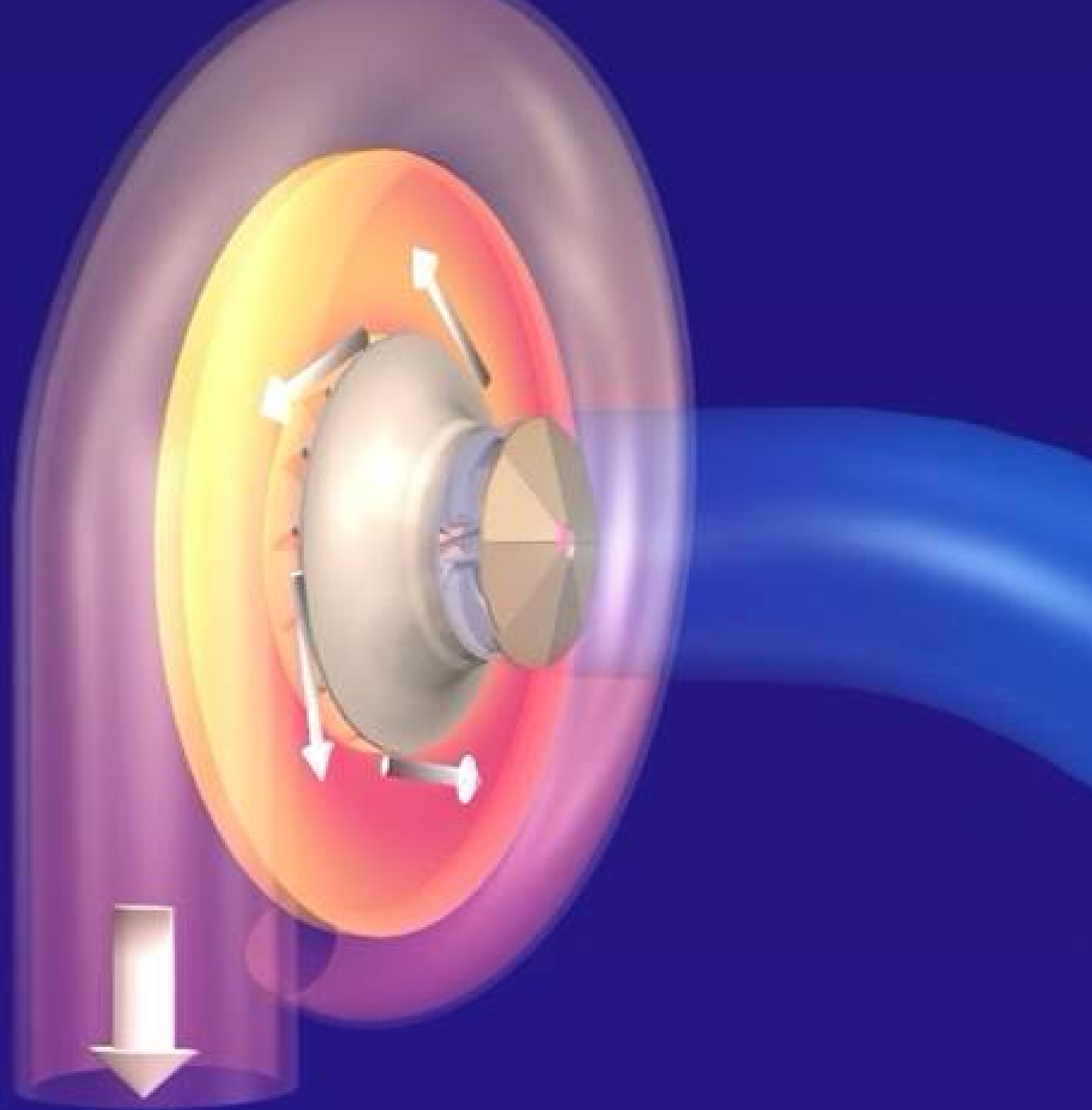


YMC²







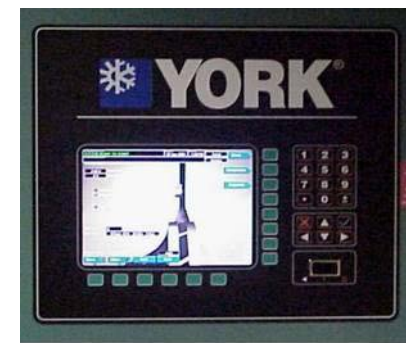


VARIABLE GEOMETRY DIFFUSER SCREEN



How is the VGD Controlled ?

Signal-In From Dynamic Pressure Transducer



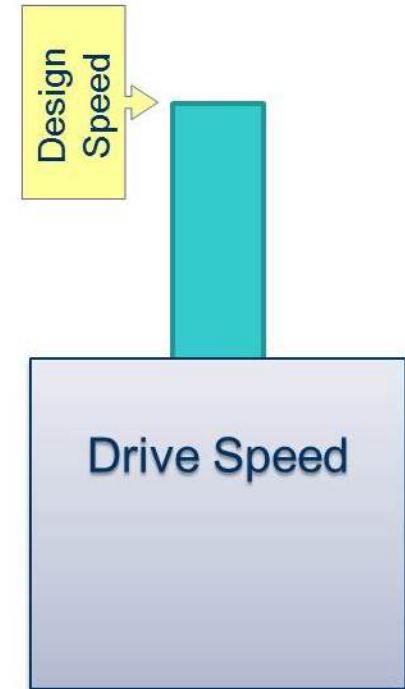
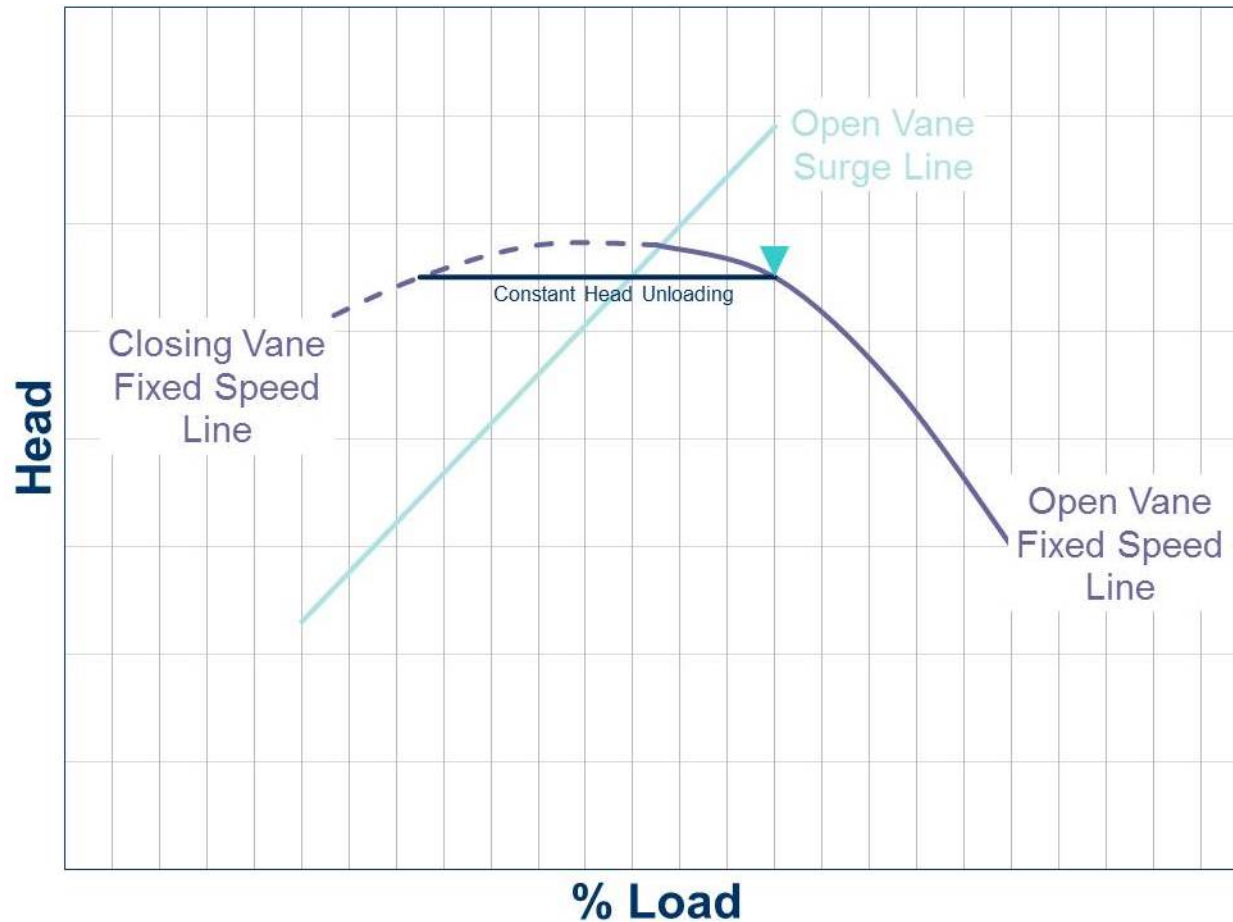
YORK *OptiView*

Adjust VGD & PRV Actuators for Optimum Performance

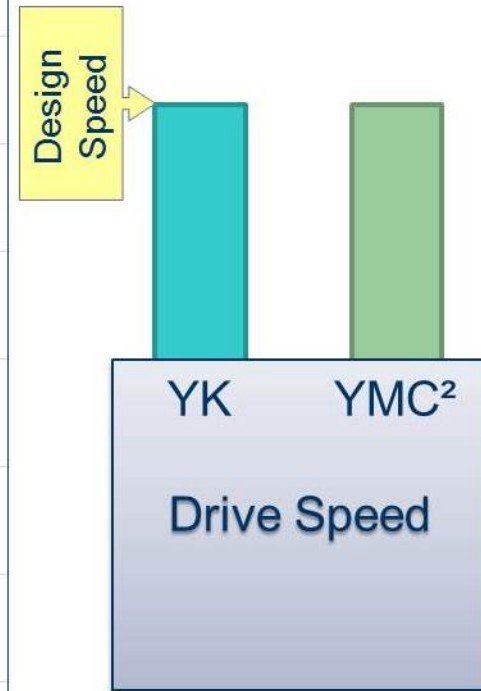
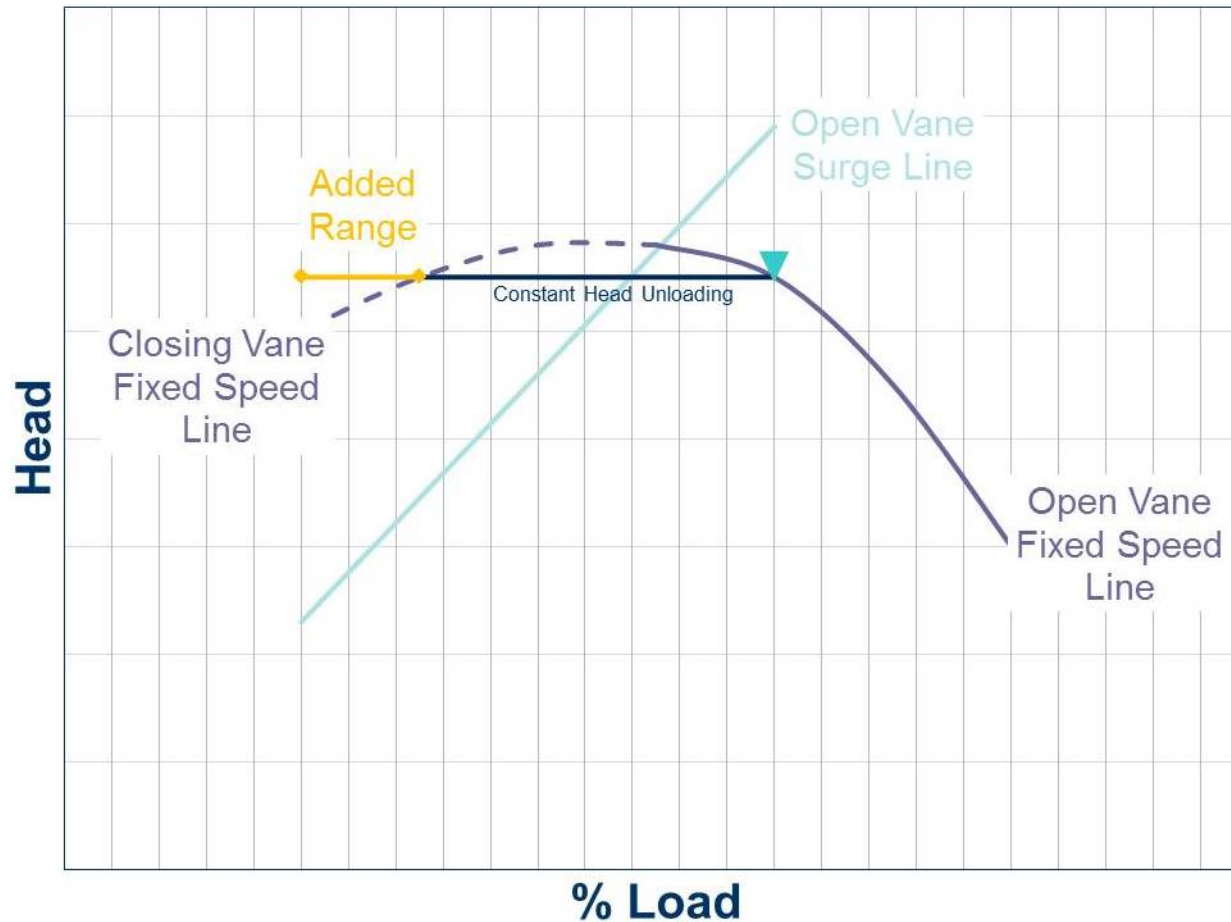




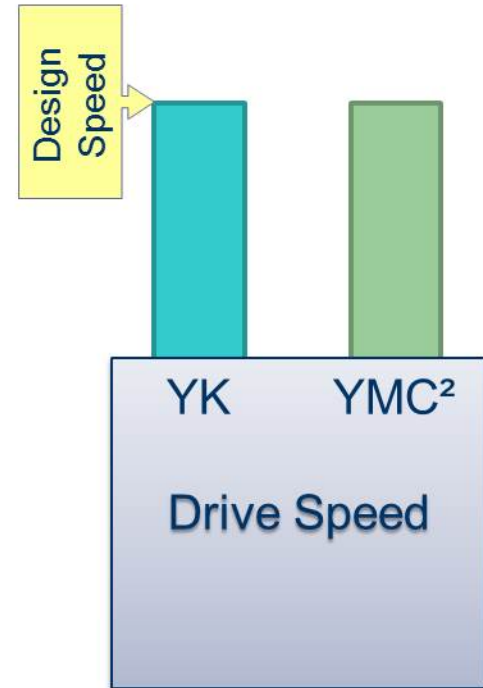
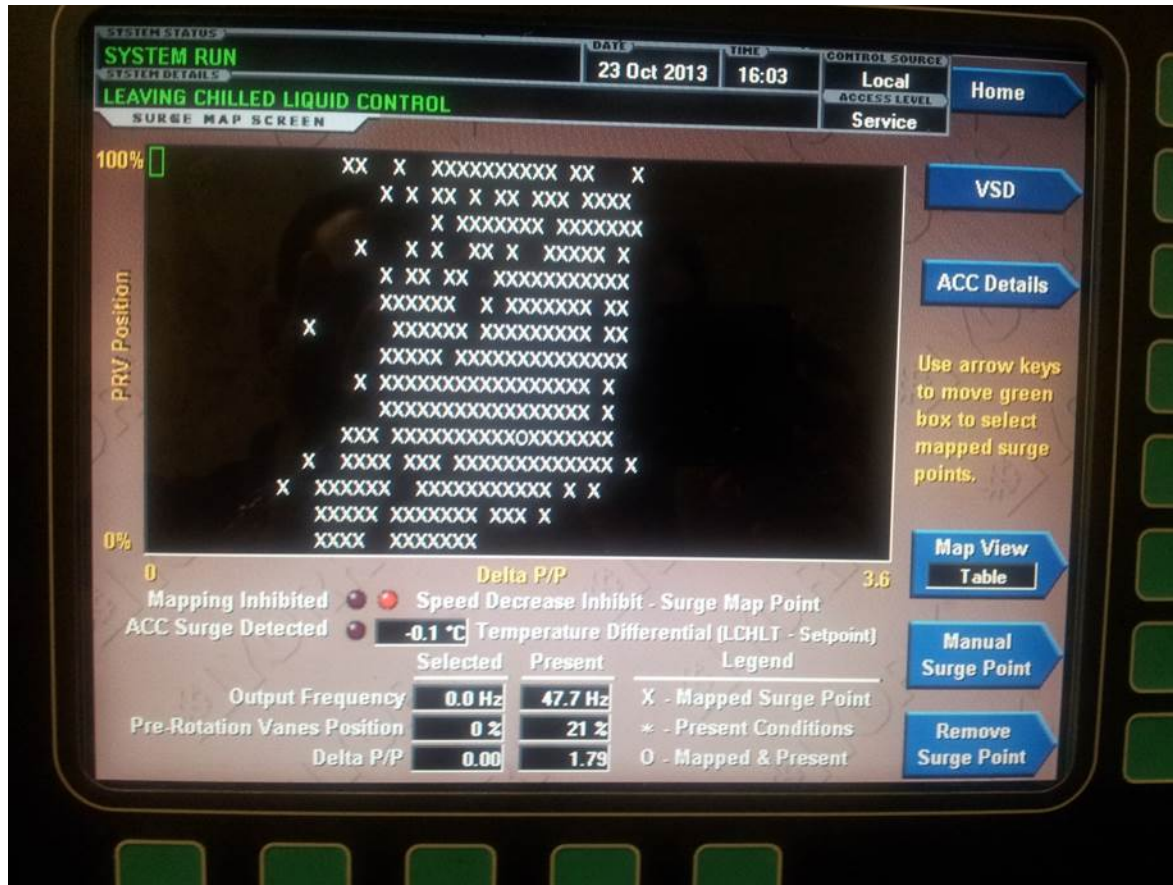
וויסות תפוקה - YK



ויסות תפוקה - YMC^2



ויסות תפוקה - YMC²



מהזדקרות סיבובית להופעת הנחשול



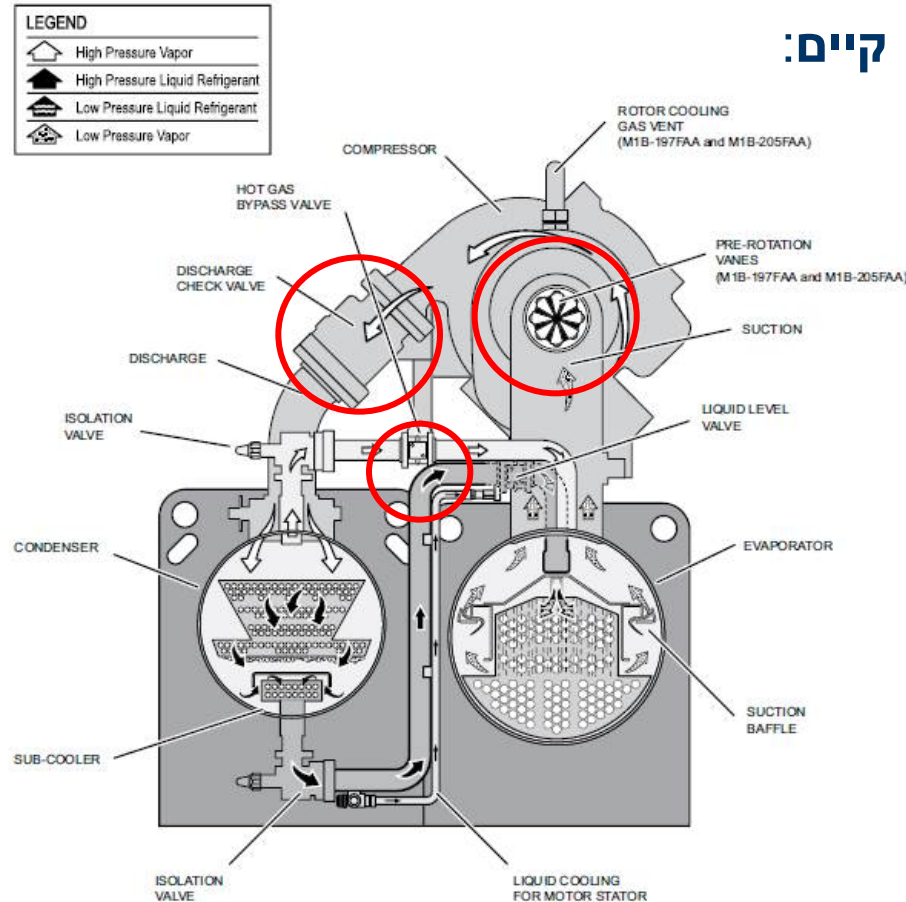
מהזדקרות סיבובית להופעת הנחשול

כיצד למנוע הזדקרות סיבובית במתקן קיים:

• לאפשר אספקת טמפ' מי עיבוי נמוכה

• להפעיל צ'ילר אחד עמוס במלואו במקום שני צ'ילרים עמוסים חלקית

• לשמור על ניקיון הצינורות במעבה



HOME SCREEN



$$E=YMC^2$$



שאלות?
תודה רבה לכם!