Table of Contents

9.6.1 Rotody	namic pumps guideline for NPSH margin
9.6.1.1 Int	roduction
9.6.1.1.1	Purpose
9.6.1.1.2	Scope
9.6.1.2 Tei	ms and definitions
9.6.1.2.1	Net positive suction head (NPSH)
9.6.1.2.2	Net positive suction head available (NPSHA)
9.6.1.2.3	Net positive suction head required (NPSHR)
9.6.1.2.4	Net positive suction head resulting in 3% loss of first-stage head (NPSH3)
9.6.1.2.5	NPSH margin
9.6.1.2.6	NPSH margin ratio
9.6.1.2.7	NPSH datum plane
9.6.1.2.8	Cavitation
9.6.1.2.9	Suction specific speed
9.6.1.2.10	Preferred operating region (POR)
9.6.1.2.11	Allowable operating region (AOR)
9.6.1.3 NF	PSH margin considerations
9.6.1.3.1	Pumpage considerations
9.6.1.3.2	Pump physical effects considerations
9.6.1.3.3	Environment and site condition (system) considerations
9.6.1.4 Ap	plication considerations
9.6.1.4.1	Petroleum (hydrocarbon) process pumps
9.6.1.4.	1.1 Pumpage considerations for petroleum (hydrocarbon) process pumps
9.6.1.4.	1.2 Pump physical effects considerations for petroleum (hydrocarbon) process pumps
9.6.1.4.	
	process pumps
	1.4 NPSH margin recommendations for petroleum (hydrocarbon) process pumps
9.6.1.4.2	Oil and gas pumps
9.6.1.4.	
9.6.1.4.	2.2 Pump physical effects considerations for oil and gas pumps
9.6.1.4.	(4,500)
9.6.1.4.	2.4 NPSH margin recommendations for oil and gas pumps
9.6.1.4.3	Chemical process pumps
9.6.1.4.	
9.6.1.4.	3.2 Pump physical effects considerations for chemical process pumps

9.6.1.4.3.3	Environment and site condition (system) considerations for chemical process pumps 11
9.6.1.4.3.4	NPSH margin recommendations for chemical process pumps
9.6.1.4.4 Ele	ctric power plant (non-nuclear) pumps
9.6.1.4.4.1	Pumpage considerations for electric power plant (non-nuclear) pumps
9.6.1.4.4.2	Pump physical effects considerations for electric power plant (non-nuclear) pumps
9.6.1.4.4.3	Environment and site condition (system) considerations for electric power plant (non-nuclear) pumps
9.6.1.4.4.4	NPSH margin recommendations for electric power plant (non-nuclear) pumps
9.6.1.4.5 Nuc	clear power plant pumps13
9.6.1.4.6 Wa	ter/wastewater pumps
9.6.1.4.6.1	Pumpage considerations for water/wastewater pumps
9.6.1.4.6.2	Pump physical effects considerations for water/wastewater pumps14
9.6.1.4.6.3	Environment and site condition (system) considerations for water/wastewater pumps 14
9.6.1.4.6.4	NPSH margin recommendations for water/wastewater pumps
9.6.1.4.7 Pul	p and paper stock pumps
9.6.1.4.7.1	Pumpage considerations for pulp and paper stock pumps
9.6.1.4.7.2	Pump physical effects considerations for pulp and paper stock pumps
9.6.1.4.7.3	Environment and site condition (system) considerations for pulp and paper stock pumps16
9.6.1.4.7.4	NPSH margin recommendations for pulp and paper stock pumps
9.6.1.4.8 Bui	Iding services pumps
9.6.1.4.8.1	Pumpage considerations for building services pumps
9.6.1.4.8.2	Pump physical effects considerations for building services pumps
9.6.1.4.8.3	Environment and site condition (system) considerations for building services pumps16
9.6.1.4.8.4	NPSH margin recommendations for building services pumps
9.6.1.4.9 Slu	rry pumps
9.6.1.4.9.1	Pumpage considerations for slurry pumps
9.6.1.4.9.2	Pump physical effects considerations for slurry pumps
9.6.1.4.9.3	Environment and site condition (system) considerations for slurry pumps
9.6.1.4.9.4	NPSH margin recommendations for slurry pumps
9.6.1.4.10 Irr	igation pumps
9.6.1.4.10.1	Pumpage considerations for irrigation pumps
9.6.1.4.10.2	Pump physical effects considerations for irrigation pumps
9.6.1.4.10.3	Environment and site condition (system) considerations for irrigation pumps
9.6.1.4.10.4	NPSH margin recommendations for irrigation pumps
9.6.1.4.11 G	eneral purpose pumps
9.6.1.4.11.1	Pumpage considerations for general purpose pumps
9.6.1.4.11.2	Pump physical effects considerations for general purpose pumps

	9.6.1	.4.11.3	Environment and site condition (system) considerations for general purpose pumps	20
	9.6.1	.4.11.4	NPSH margin recommendations for general purpose pumps	20
Appen	dix A	NPSH	A determination and considerations (Informative)	21
A.1	Intr	oduction		21
A.2	Equ	uation for	NPSHA	21
A.3	NP	SHA equ	ation parameters	22
A.	3.1	Atmosph	neric pressure head (h _{atm})	22
A.	3.2	Vapor pr	ressure head $(h_{_{vp}})$	23
A.	3.3	Suction	gauge head (h _{gs})	23
A.	3.4	Suction	velocity head (h _{vs})	23
A.	3.5	Vertical	distance from suction gauge datum to NPSH datum plane $(z_{_{s}})\dots$	24
A.	3.6	Suction	head loss (h _f)	24
A.	3.7	Accelera	ation head (h _a)	24
A.4	NP		mple calculations	
A.	4.1	NPSHA	calculation example in metric units (simple)	25
A.	4.2	NPSHA	calculation example at higher temperature and elevation in metric units (complex)	26
A.	4.3	NPSHA	calculation example in US customary units (simple)	28
A.	4.4	NPSHA	calculation example at higher temperature and elevation in US customary units (complex)	29
A.5	NP	SHA dete	ermination additional considerations	31
A.	5.1	Straighte	ening vanes and similar flow conditioning devices	31
A.	5.2	Suction	screen and strainer	31
A.6	NP	SHA dete	ermination over range of operation	31
Appen	dix B	3 Comp	ensating for insufficient NPSH margin (Informative)	32
B.1	Intr	oduction		32
B.2	Ma	terials res	sistant to erosion from cavitation	32
B.3	Red	ducing pu	ımp operating speed	33
B.4	Cha	ange imp	eller diameter	34
B.5	Alte	ernate pu	mp selection	34
B.6	Pur	mps in pa	ırallel	34
B.7	Lov	v NPSHF	R first stage or booster pump	35
B.8	Sys	stem or o	perational modifications	35
B.9	Cor	nsult pum	np manufacturer	35
B.	9.1	Inducer		35
B.	9.2	Modified	l impeller inlet	36
B.	9.3	Alternate	e impeller designs	36
Appen	dix C	Refere	ences	37

Figures

Figure 9.6.1.3.3.3	NPSH margin applied to operating regions	6
Figure 9.6.1.3.3.7	NPSH margin variation for system modulated by control valve	8
Figure A.2 Datur	m elevation for various pump designs at the eye of first-stage impeller	22
Figure A.4.1 Sch	nematic of NPSHA calculation example in metric units (simple)	25
Figure A.4.2 Sch	nematic of NPSHA calculation example in metric units (complex)	27
Figure A.4.3 Sch	nematic of NPSHA calculation example in US customary units (simple)	28
Figure A.4.4 Sch	nematic of NPSHA calculation example in US customary units (complex)	30
Chart B.2 Wear r	resistance of metal alloys relative to cast iron	32
Figure B.3a Effect	cts of reduced speed on NPSH margin	33
Figure B.3b Adeo	quate NPSH margin vs. no margin	34
Tables		
Table 9.6.1.4.1.4	NPSH margin, petroleum (hydrocarbon) process pumps	10
Table 9.6.1.4.2.4	NPSH margin, oil and gas pumps	11
Table 9.6.1.4.3.4	NPSH margin, chemical process pumps	12
Table 9.6.1.4.4.4	NPSH margin, electric power plant (non-nuclear) pumps	13
Table 9.6.1.4.6.4	NPSH margin, water/wastewater pumps	15
Table 9.6.1.4.7.4	NPSH margin, pulp and paper stock pumps, <6% solids	16
Table 9.6.1.4.8.4	NPSH margin, building services pumps	17
Table 9.6.1.4.9.4	NPSH margin, slurry pumps	18
Table 9.6.1.4.10.4	NPSH margin, irrigation pumps	19
Table 9.6.1.4.11.4	NPSH margin, general purpose pumps	20