GRUNDFOS

WHITE PAPER

Pump Troubleshooting

by Steve Wilson

As a machine, the nature of a pump is such that, it will ultimately fail, or have components that fail. The time between failures and the nature of the failures can be mitigated through proper selection, installation, and maintenance. However, since it can be expected that they will fail, most user guides (Installation, Operation, and Maintenance Manuals) provide some sort of troubleshooting. This paper will provide some insight into utilizing those user guides, and illustrate one possible alternate approach which may be valuable in troubleshooting a pump or pumping system.

TYPES OF SYMPTOMS

Generally, pump troubleshooting begins when one of the following situations arise:

- Lack of adequate flow (or too much flow)
- Lack of adequate pressure (or too much pressure)
- Mechanical problems
- Motor / drive problems

Unfortunately, when any of these situations occur, many users "blame" the pump, pull it from service, and start "tearing it apart", or only slightly better), they call the manufacturer.

Use of the guides discussed herein should illustrate a more suitable approach, which can yield superior results while minimizing (or eliminating) downtime.

TYPICAL TROUBLESHOOTING GUIDE

Typically, published troubleshooting guides begin with a list of symptoms and a cause code as shown in *Figure 1*, with causes defined similar to that shown in Figure 2 .

Symptom	Cause Code
Pump does not deliver any liquid at start-up.	1*2*3*4*5*6*7*8*9*10*11*14*16*17*22*23*24*34
Pump stops delivering liquid after start-up.	2*3*4*5*6*7*8*9*10*11*12*13*22*23*24*34
Pump overheats and/or ceases to deliver liquid.	1*3*9*10*11*21*22*27*29*30*31*33*34*40*41
Insufficient flow rate.	2*3*4*5*6*7*8*9*10*11*14*16*17*20*21*22*23*24*25*26*34
Excessive flow rate.	15*18*20*34
Discharge pressure is too high.	4*14*16*18*20*22*23*24*25*26*34
Shaft seal leaks appreciably, or the packing leaks excessively.	27*28*29*30*33*34*35*36*39*41
Shaft seal or packing fails prematurely.	12*13*27*28*29*30*33*34*35*36*37*38*39*41
Pump uses too much power.	15*16*18*19*20*23*25*27*28*31*33*34*35*37*38*44
Pump runs rough and noisily.	2*3*4*5*6*7*8*9*10*11*15*17*18*21*23*24*27*28*29*30*
	31*32*33*34*40*41*42*45*46*
Bearings overheat and/or fail prematurely.	27*28*29*30*31*32*33*34*40*41*42*43*44*45*46

Figure 1. *Typical troubleshooting symptoms guide*

Code	Cause	Code	Cause
1	The pump has not been properly bled of air.	28	The shaft may chatter because it is bent.
2	The pump suction line have not been completely primed.	29	The pump may run rough due to improper balancing of the impeller.
3	The suction head (NPSHR) required by the pump is too high, or the net positive suction head available (NPSHA) at your facility is too low.	30	The shaft may not be running due to worn bearings.
4	The fluid pumped contains too much entrained air or gas.	31	The impeller may be rubbing against the inside of the case.
5	There are air pockets in the suction line.		
6	An entry of air has suddenly occurred in the suction line.	33	The pump may have become misaligned during installation.
7	An entry of air past the shaft seal into the pump has occurred.	34	The operating conditions of the installation do not agree with the data specified when the pump was purchased.
8	The inlet of the suction line is insufficiently submerged.		
9	The suction valve is closed or only partially open.	35	The shaft seal may be incorrectly installed, or the stuffing box has not been packed correctly.
10	The suction strainer is clogged with dirt or debris.		
11	The foot valve is clogged or undersized.	36	The shaft sleeve may be scored or pitted in the region of the packing due to dirt or abrasive matter in the flushing fluid.
12	Little or no cooling fluid supplied to the shaft seals.		
13	The lantern ring is not positioned opposite the flushing inlet thereby restricting fluid flow.		
14	Pump drive rotational speed too low.	37	Excessive tightening of the packing gland may block the flushing port thereby diminishing the sealing fluid flow.
15	Pump drive rotational speed too high.		
16	Pump rotation wrong or impeller installed backwards.	38	Packing material may have become wedged or extruded between the shaft and the bottom of the stuffing housing due to excessive clearance on the packing backup washer.
17	Total head of installation (back Pressure) higher than rated total head of the pump.		
18	Total head of installation (back Pressure) lower than rated total head of the pump.		
19	Density of fluid pumped differs from that specified when the pump was purchased.	39	The mechanical seal may have been damaged by running dry.
20	Viscosity of fluid pumped differs from that specified when the pump was purchased.	40	There may be excessive axial thrust (side loading) due to improper impeller central alignment.
		41	The bearings may be worn.
21	The pump is operating at too low a rate of flow (The discharge valve may be throttled too much).	42	The bearings may have been damaged during installation and/or dirt or other foreign matter may have entered the bearings during greasing or oiling.
22	If pumps are operating in parallel, the pump characteristics may not be suitable for parallel operation.		
23	The impeller may be clogged with debris.	43	Excessive greasing may cause the bearings to overheat.
24	The impeller may be damaged.		
25	The casing and impeller wear rings may be excessively worn.	44	Inadequate lubrication may be causing bearing
26	There may be internal leakage from the discharge to the suction compartments as the result of internal gasket failure.	45	Dirt may have entered the bearings past the O-Rings.
27	There may be a misalignment of the pump shaft.	46	Moisture may have entered the bearing housing causing the bearings to rust.

Figure 2. *Cause code defined*

TOOLS REQUIRED FOR PUMP TROUBLE-SHOOTING

Prior to looking at the details of an alternate approach, it is important to note a few assumptions and basic tools that are necessary, besides the tools required for pump disassembly and re-assembly.

Assumptions:

- Pump troubleshooting should not be attempted unless the individual doing so has a firm grasp and training on safety precautions.
- Pump troubleshooting should not be attempted unless the individual doing so has a general understanding of pump hydraulics and nomenclature.

A Different Approach

The following approach uses "decision trees" to lead the user, step by step, to the possible causes of a perceived problem, while eliminating those items which will *not* cause the perceived problem. Each chart is developed based on a given set of circumstances:

- Chart 1A - Flow is lower than expected and head is higher than expected
- Chart 1B - Flow is lower than expected and head is higher than expected
- Chart 2A - Flow is higher than expected and head is higher than expected
- Chart 2B - Flow is lower than expected and head is lower than expected
- Chart 3 - Mechanical Problems
- Chart 4 - Motor Overload Problems

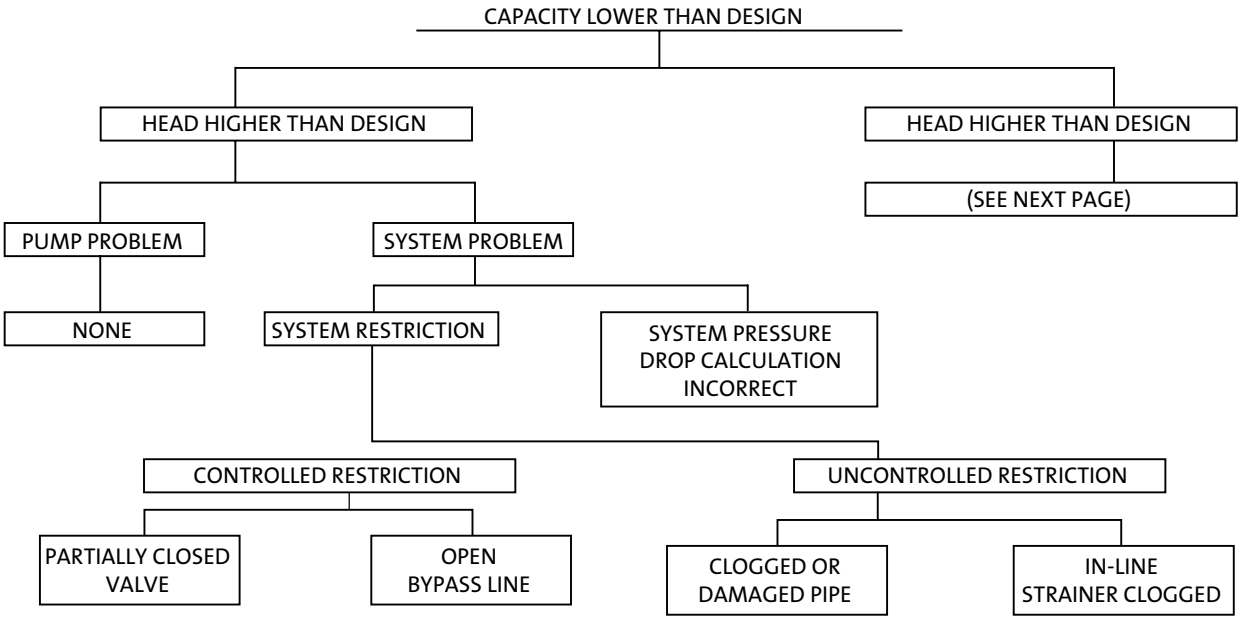

Chart 1A. *Flow is lower than expected and head is higher than expectd.*

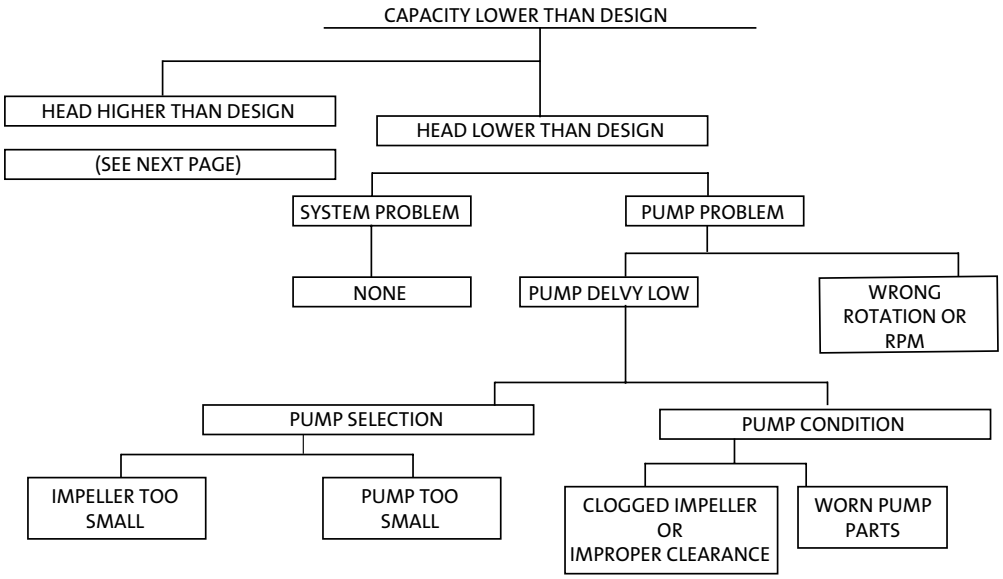

Chart 1B. *Flow is lower than expected and head is higher than expected.*

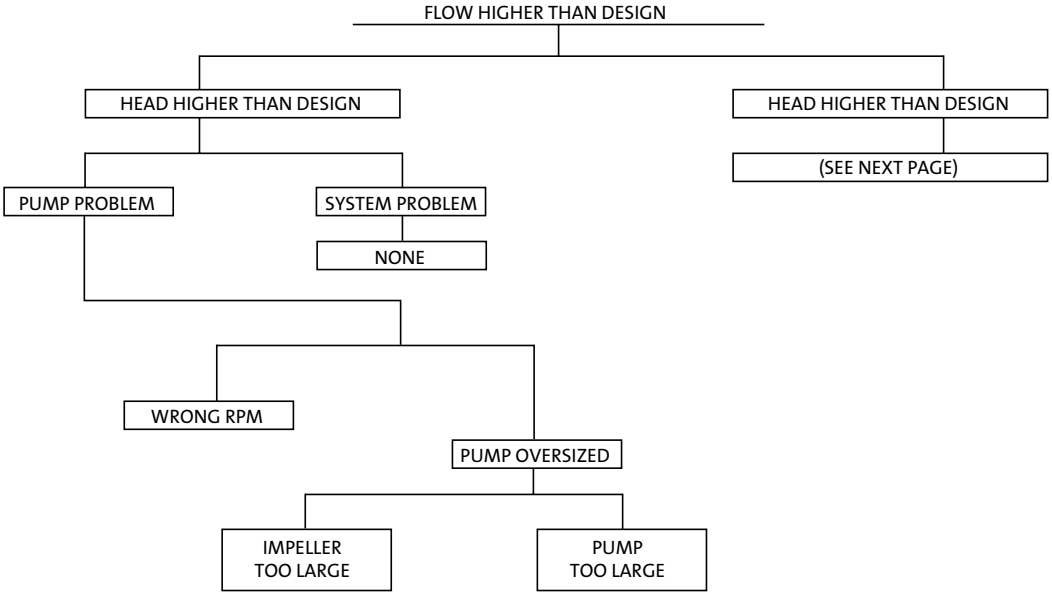

Chart 2A. *Flow is higher than expected and head is higher than expected.*

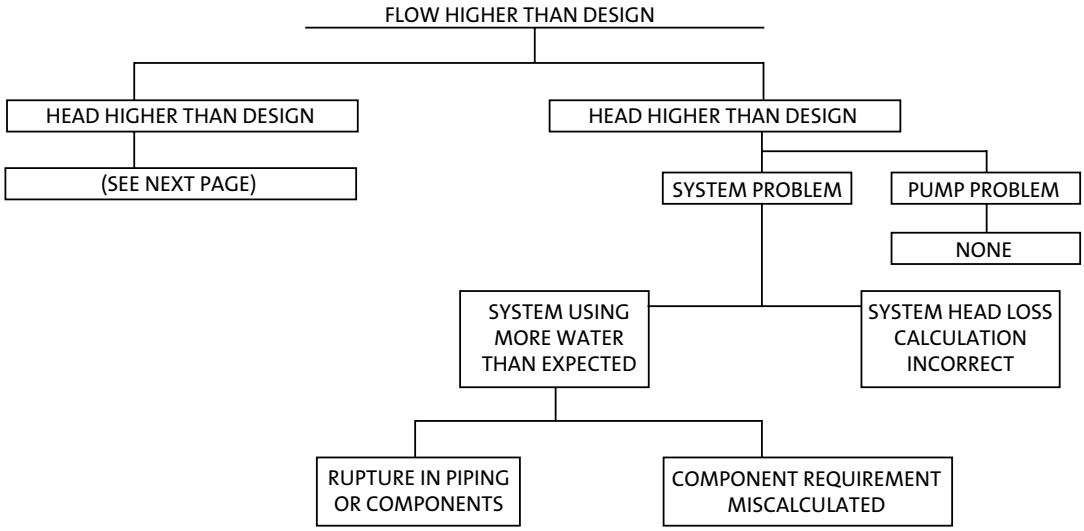

Chart 2B. *Flow is lower than expected and head is lower than expected.*

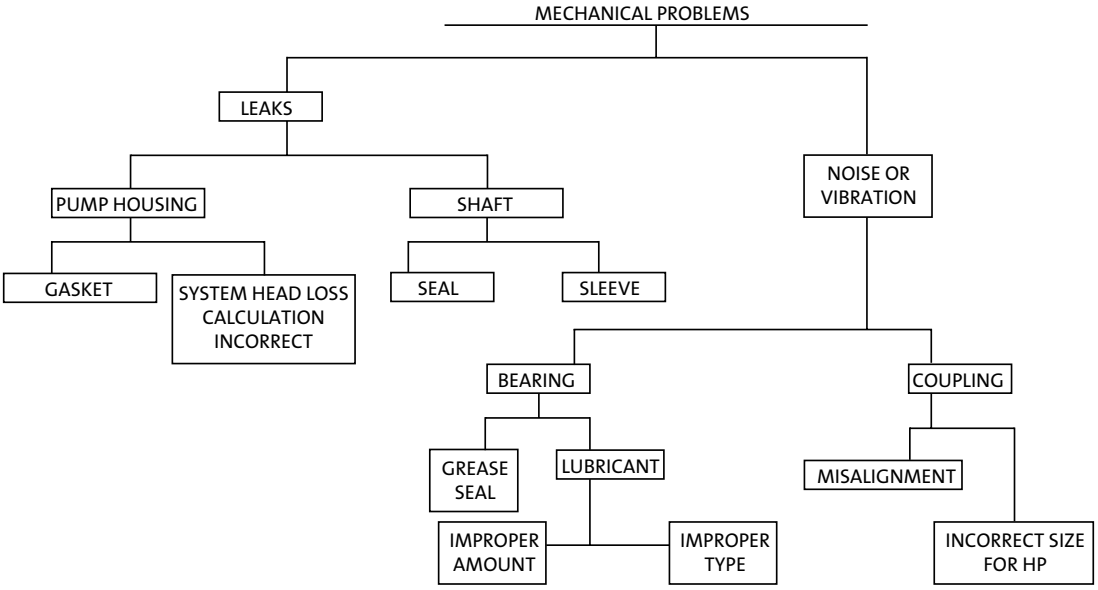

Chart 3. *Mechanical Problems*

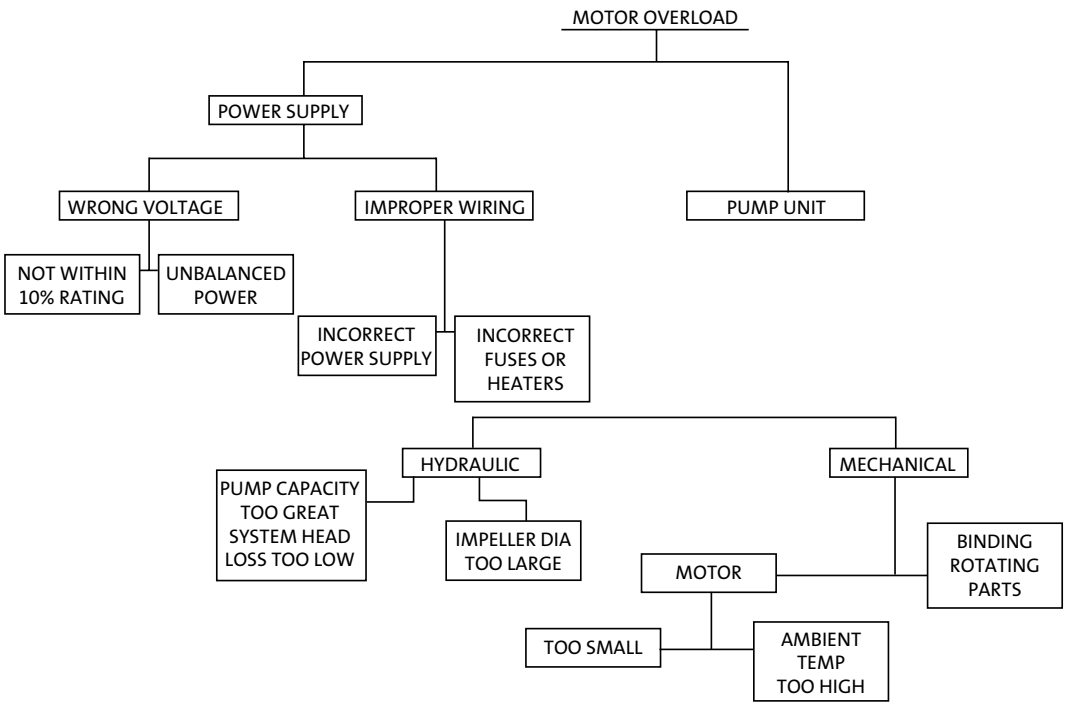

Chart 4. *Motor Overload Problems*

Approach Overview and Comments

It should be apparent that this approach quickly narrows the gap between "I have a pump problem" and a very specific set of items to explore. Yet, an understanding of pump construction and hydraulic facts may narrow the gap even more. When a pump is disassembled, it is helpful to know exactly what to look for.

One Example

For this example, capacity is lower than expected, and head is lower than expected: The pump is not delivering the water needed and not providing the needed pressure. *Chart 2B* would be referenced in this situation.

A pump problem is indeed observed. Following the decision tree progression, the first order of business is to determine whether or not the pump is rotating in the right direction. While normally expected only in new pumps, such condition might be expected if there is phase reversal, so that should be checked. If it proves to be OK, the pump is turning the correct direction. In a new installation the pump nameplate should be checked to the plans to verify that the right pump is in place. In an existing installation, it can be expected that the pump is not too small, and it has been working without incident until now. It can be concluded that worn pump parts, a clogged pump, or improper clearances is causing the problem.

Would it be advisable to shut the pump down immediately and investigate further? Probably not.

Due to what is known about pumps, more can be determined:

- If the problem is clogging, it can be expected that the pump is drawing low amps. The pump is doing less work. Disassembly and clog removal is indicated.

- If the problem is worn pump parts, the amp draw would be expected to remain approximately where it has been historically.

It is observed that the pump is pumping and re-circulating the fluid. If this is the case, before the pump is taken out of service, it should be ascertained that there is a backup pump available and /or the supplier has wear rings and possibly new impellers available.

If the pump is showing high amps, one of two situations may be causing the low delivery and low pressure:

- The clearances are too tight, causing binding. (This might be expected after a pump has been re-worked or is new.)
- The clearances are actually too loose and are worn, allowing obstructions to lodge between the rotating piece and stationary pieces.

CONCLUSION

Regardless of which approach is used in this example or in any attempt to address a pump's problem, pump troubleshooting is always an exercise that should include hydraulic and mechanical observations. Observing the conditions will allow a focused approach to the problem, rather than focusing on the symptoms, so that decisions can be made about courses of action which will limit downtime and avoid unnesessary expense.

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