RSD-J with Right Hand Gearbox

Temperature Testing to Validate Right Hand (RH) Gearbox Configuration of RSD-J Pump

Company:

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Title: Mechanical Engineer

Date: 20-May-2014

Document No.:

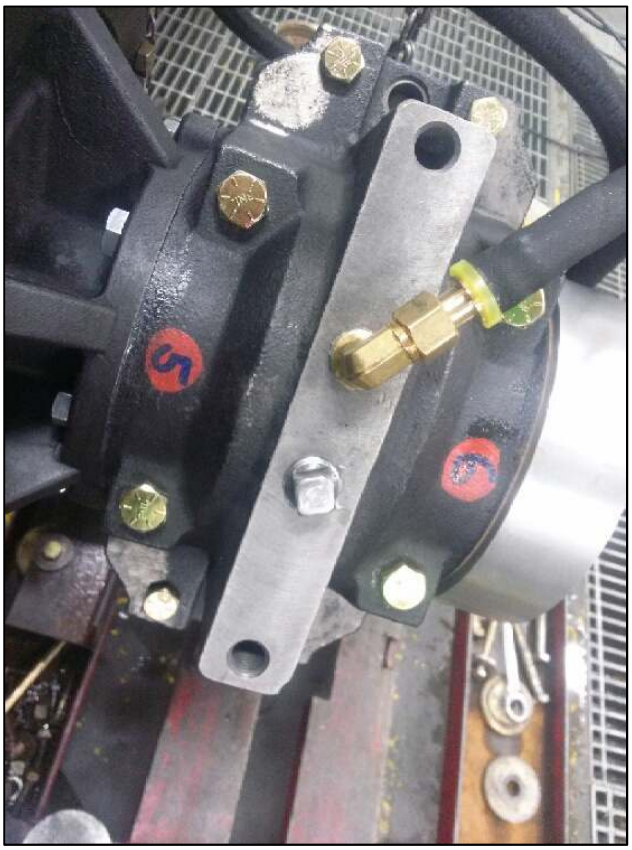
Abstract

The purpose of this report is to summarize the temperature testing results of the RSD-J with right hand (RH) gearbox configuration. Testing was performed on different days and with a variety of conditions to prove out the optimum oil pump plumbing and oil level to keep gearbox temperatures as low as possible. The right hand gearbox configuration was required to satisfy customer orders for trucks with PTOs located on the right hand side of the transmission. The as-built configurations, operational test conditions and test results are broken into sections by date and detailed in the following pages.

The first and final test, most closely resembling the actual build per the PL1202AC drawing, performed the best once the oil level was confirmed to be halfway in the sight gauge. All bearing temperature measurements were below the Hale maximum allowable limits of 225°F after a run time of 3 hours and 40 minutes. A clear image of the approved configuration can be found in the conclusion section of this report.

Location of Temperature Test Points

1. Input shaft bearing – flange side (not shown below)
2. Input shaft bearing – oil pump side
3. Idler shaft bearing – flange side
4. Idler shaft bearing – oil pump side
5. Pump shaft bearing – at pump head
6. Pump shaft bearing – at gearbox bearing cap
7. Gearbox oil sump



Date: 05-08-2014 (Evening)
Pump: RSD125-18J with RH gearbox configuration (1.80 ratio)
Serial No: H04882-005
Conditions: 1320 GPM, 150 PSI, 15.6 inHg, 171 HP, 2177 Input RPM.
016-5130-00-0 impeller & 016-1080-00-0 inducer.
Standard oil pump plumbing with oil feed line installed in gearbox cap.
217-3370-00-0 sight gauge installed, don't know true oil level due to required breather extensions to keep pump from burping oil.
Pump built like images shown above in "Location of Temp. Test Points".

Actual Time	Time (Min)	Pit (°F)	#1 (°F)	#2 (°F)	#3 (°F)	#4 (°F)	#5 (°F)	#6 (°F)	#7 (°F)
8:50 PM	10	80	97	95	89	92	107	106	-
9:00 PM	20	79	127	122	116	122	135	132	124
9:10 PM	30	79	141	141	135	143	155	168	141
9:20 PM	40	79	160	157	152	163	164	192	158
9:30 PM	50	79	163	161	158	170	167	197	161
9:40 PM	60	79	169	165	162	178	171	207	165
9:50 PM	70	79	173	170	164	185	172	211	169
10:00 PM	80	79	174	173	166	185	173	213	169
Reduce pump to 500 GPM @ 100 PSI and run for 10 minutes to confirm temperatures drop.									
10:10 PM	90	80	165	168	163	180	180	194	161

Date: 05-09-2014 (Morning)
Pump: RSD125-18J with RH gearbox configuration (1.80 ratio)
Serial No: H04882-005
Conditions: 660 GPM, 250 PSI, 12.1 inHg, 158 HP, 2408 Input RPM.
016-5130-00-0 impeller & 016-1080-00-0 inducer.
Standard oil pump plumbing with oil feed line installed in gearbox cap.
217-3370-00-0 sight gauge installed, don't know true oil level due to required breather extensions to keep pump from burping oil.
Pump built like images shown above in "Location of Temp. Test Points".

Actual Time	Time (Min)	Pit (°F)	#1 (°F)	#2 (°F)	#3 (°F)	#4 (°F)	#5 (°F)	#6 (°F)	#7 (°F)
6:20 AM	10	78	93	88	84	88	112	113	80
6:30 AM	20	79	110	109	102	110	134	128	98
6:40 AM	30	79	123	125	118	129	148	151	112
6:50 AM	40	79	132	135	126	144	154	159	118
7:00 AM	50	79	140	142	137	154	163	171	127
7:10 AM	60	79	142	148	141	159	165	174	129
7:20 AM	70	79	142	150	142	166	166	175	131
7:30 AM	80	79	144	152	143	169	167	178	139
Reduce pump to 500 GPM @ 100 PSI and run for 10 minutes to confirm temperatures drop.									
7:40 AM	90	80	138	149	135	162	154	168	133

Date: 05-14-2014 (Early AM)
Pump: RSD125-18J with RH gearbox configuration (1.80 ratio)
Serial No: H04882-005
Conditions: 1320 GPM, 150 PSI, 15.6 inHg, 180 HP, 2197 Input RPM.
016-5130-00-0 impeller & 016-1080-00-0 inducer.
Oil level raised approximately 1.00 inch by adding 082-0414-02-0 elbow and 217-0401-01-0 plug.
Oil pump plumbing consistent with testing performed 05-08 and 05-09.

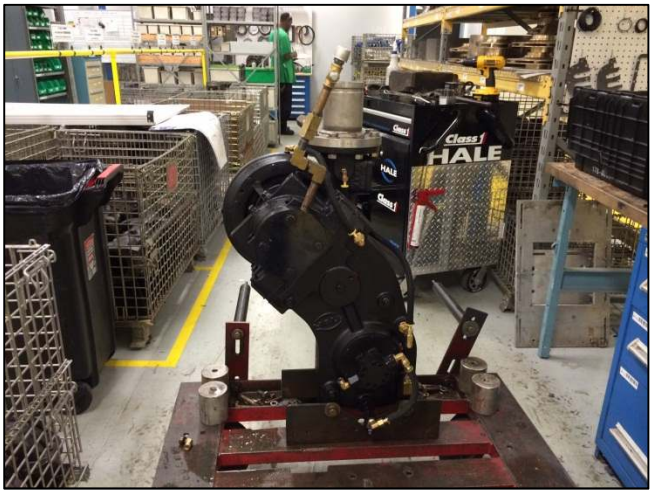
Actual Time	Time (Min)	Pit (°F)	#1 (°F)	#2 (°F)	#3 (°F)	#4 (°F)	#5 (°F)	#6 (°F)	#7 (°F)
12:20 AM	10	79	129	126	121	125	135	145	122
12:30 AM	20	79	153	153	147	155	159	169	151
12:40 AM	30	79	171	173	167	173	179	185	166
12:50 AM	40	79	182	182	179	185	185	192	178
1:00 AM	50	79	187	188	182	190	192	198	186
1:10 AM	60	79	192	194	187	197	198	202	187
1:20 AM	70	79	193	197	191	198	199	205	192
1:30 AM	80	79	195	197	194	198	199	206	194
Reduce pump to 500 GPM @ 100 PSI and run for 10 minutes to confirm temperatures drop.									
1:40 AM	90	79	181	184	180	187	181	193	177

Date: 05-14-2014 (Morning)
Pump: RSD125-18J with RH gearbox configuration (1.80 ratio)
Serial No: H04882-005
Conditions: 660 GPM, 250 PSI, 12.1 inHg, 162 HP, 2397 Input RPM.
016-5130-00-0 impeller & 016-1080-00-0 inducer.
Oil level raised approximately 1.00 inch by adding 082-0414-02-0 elbow and 217-0401-01-0 plug.
Oil pump plumbing consistent with testing performed 05-08 and 05-09.

Actual Time	Time (Min)	Pit (°F)	#1 (°F)	#2 (°F)	#3 (°F)	#4 (°F)	#5 (°F)	#6 (°F)	#7 (°F)
6:40 AM	10	79	114	119	112	110	130	136	117
6:50 AM	20	78	144	148	141	122	152	164	145
7:00 AM	30	78	151	161	155	134	163	174	154
7:10 AM	40	78	161	172	167	154	172	184	169
7:20 AM	50	78	168	178	174	169	178	189	175
7:30 AM	60	78	171	185	176	180	180	194	178
7:40 AM	70	78	171	186	182	182	184	196	182
7:50 AM	80	78	173	188	184	190	186	199	183
Reduce pump to 500 GPM @ 100 PSI and run for 10 minutes to confirm temperatures drop.									
8:00 AM	90	79	162	176	175	175	173	188	170

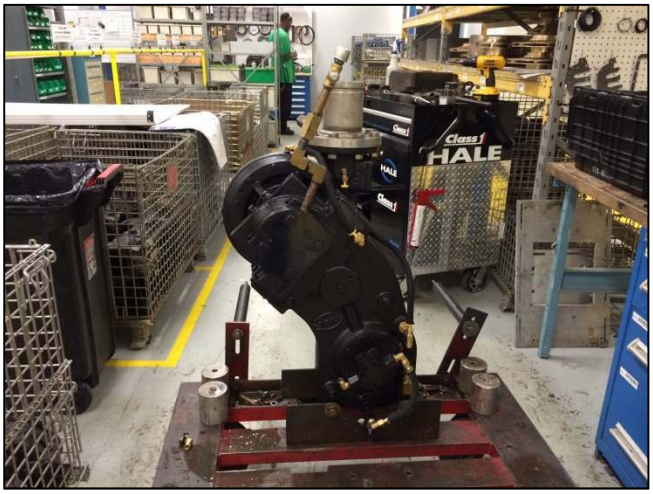
RSD-J Right Hand (RH) Gearbox Temperature Testing					
UNIT	RSD-J with Right Hand Gearbox	ECN	CFL3243	PAGE	6 OF 14
TYPE	Single Stage PTO Driven Booster Pump	DOC #		REV	A

Date: 05-14-2014 (Evening)
Pump: RSD125-18J with RH gearbox configuration (1.80 ratio)
Serial No: H04882-005
Conditions: 1320 GPM, 150 PSI, 15.6 inHg, HP and RPM not recorded during test.
016-5130-00-0 impeller & 016-1080-00-0 inducer.
Oil level raised approximately 1.00 inch by adding 082-0414-02-0 elbow and 217-0401-01-0 plug.
Oil pump plumbing relocated to feed gearbox rear bearing cap.
Many breather extensions had to be added to keep gearbox from burping.



Actual Time	Time (Min)	Pit (°F)	#1 (°F)	#2 (°F)	#3 (°F)	#4 (°F)	#5 (°F)	#6 (°F)	#7 (°F)
7:00 PM	10	83	127	124	115	121	136	134	116
7:10 PM	20	83	157	156	147	154	160	163	151
7:20 PM	30	83	163	169	163	170	170	175	160
7:30 PM	40	83	175	180	173	181	181	186	161
7:40 PM	50	83	183	190	185	193	191	196	182
7:50 PM	60	83	189	196	190	199	195	201	183
8:00 PM	70	83	193	201	185	203	201	207	192
8:10 PM	80	83	196	204	198	207	203	210	198
Reduce pump to 500 GPM @ 100 PSI and run for 10 minutes to confirm temperatures drop.									
8:20 PM	90	82	184	188	183	192	185	190	179

Date: 05-15-2014 (Morning)
Pump: RSD125-18J with RH gearbox configuration (1.80 ratio)
Serial No: H04882-005
Conditions: 660 GPM, 250 PSI, 12.1 inHg, 157 HP, 2412 input RPM.
016-5130-00-0 impeller & 016-1080-00-0 inducer.
Oil level raised approximately 1.00 inch by adding 082-0414-02-0 elbow and 217-0401-01-0 plug.
Oil pump plumbing relocated to feed gearbox rear bearing cap.
Many breather extensions had to be added to keep gearbox from burping.



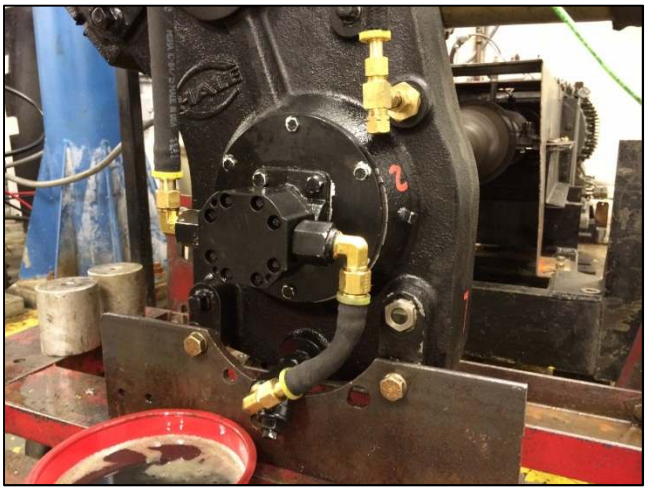
Actual Time	Time (Min)	Pit (°F)	#1 (°F)	#2 (°F)	#3 (°F)	#4 (°F)	#5 (°F)	#6 (°F)	#7 (°F)
6:30 AM	10	81	107	106	98	103	128	120	107
6:40 AM	20	81	134	133	126	133	148	145	135
6:50 AM	30	81	144	150	148	151	161	162	144
7:00 AM	40	81	155	163	159	161	169	172	159
7:10 AM	50	81	162	170	167	171	171	181	163
7:20 AM	60	82	167	178	171	174	175	185	169
7:30 AM	70	82	170	180	174	182	180	188	176
7:40 AM	80	82	172	184	176	185	185	192	175
Reduce pump to 500 GPM @ 100 PSI and run for 10 minutes to confirm temperatures drop.									
7:50 AM	90	83	158	173	170	173	166	180	160

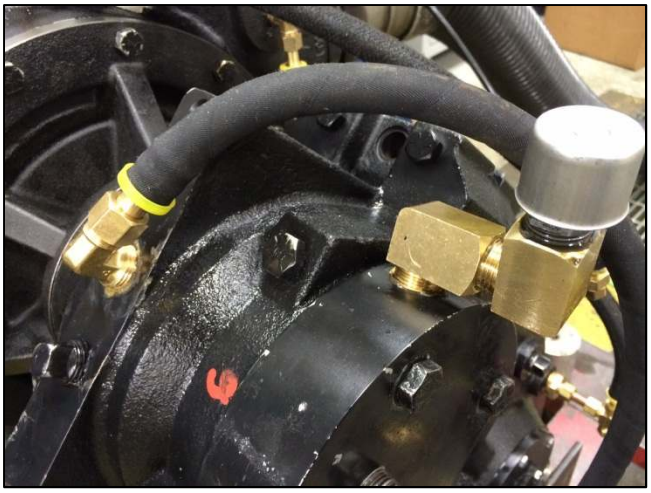
RSD-J Right Hand (RH) Gearbox Temperature Testing					
UNIT	RSD-J with Right Hand Gearbox	ECN	CFL3243	PAGE	8 OF 14
TYPE	Single Stage PTO Driven Booster Pump	DOC #		REV	A

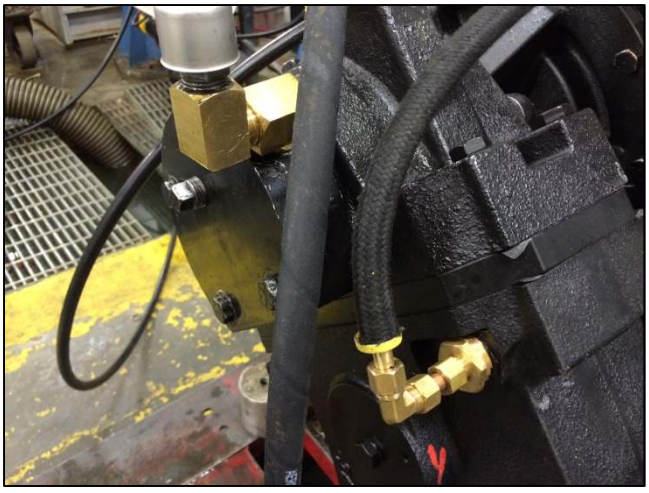
Date: 05-15-2014 (Evening)
Pump: RSD125-18J with RH gearbox configuration (1.80 ratio)
Serial No: H04882-005
Conditions: 1320 GPM, 150 PSI, 15.6 inHg, 191 HP, 2292 input RPM.
016-5130-00-0 impeller & 016-1080-00-0 inducer.
Oil level raised approximately 1.00 inch by adding 082-0414-02-0 elbow and 217-0401-01-0 plug.
Oil pump plumbing relocated to feed gearbox rear bearing cap.
Oil pump "bypass" hose added with pipe tee to reduce breather extensions required.

Actual Time	Time (Min)	Pit (°F)	#1 (°F)	#2 (°F)	#3 (°F)	#4 (°F)	#5 (°F)	#6 (°F)	#7 (°F)
4:05 PM	10	86	141	140	135	141	149	148	135
4:15 PM	20	86	160	162	156	163	166	168	153
4:25 PM	30	86	178	180	171	179	180	181	165
4:35 PM	40	86	186	190	182	192	190	193	183
4:45 PM	50	86	194	201	194	201	197	201	193
4:55 PM	60	86	198	204	197	205	200	207	197
5:05 PM	70	86	200	203	198	205	203	206	197
5:15 PM	80	85	204	208	200	210	201	205	201
5:25 PM	90	85	204	209	202	213	204	208	204
5:35 PM	100	85	207	211	203	212	207	211	204
5:45 PM	110	86	207	211	204	213	208	213	205
5:55 PM	120	86	206	210	204	213	208	213	203
Reduce pump to 500 GPM @ 100 PSI and run for 10 minutes to confirm temperatures drop.									
6:05 PM	130	86	190	191	191	199	192	199	187

Date: 05-16-2014
Pump: RSD125-18J with RH gearbox configuration (1.80 ratio)
Serial No: H04882-005
Conditions: 1500 GPM, 150 PSI, 17.0 inHg, 215 HP, 2110 input RPM.
016-1050-00-0 impeller & 016-1080-00-0 inducer.
Oil level returned to original level using 217-3370-00-0 sight gauge.
Oil pump plumbing returned to original 05-08 & 05-09 configuration.







RSD-J Right Hand (RH) Gearbox Temperature Testing					
UNIT	RSD-J with Right Hand Gearbox	ECN	CFL3243	PAGE	10 OF 14
TYPE	Single Stage PTO Driven Booster Pump	DOC #		REV	A

Actual Time	Time (Min)	Pit (°F)	#1 (°F)	#2 (°F)	#3 (°F)	#4 (°F)	#5 (°F)	#6 (°F)	#7 (°F)
12:00 PM	10	81	126	124	117	122	133	146	123
12:10 PM	20	81	142	143	135	143	146	166	142
12:20 PM	30	81	155	158	151	158	161	179	157
12:30 PM	40	81	161	167	161	169	168	188	167
12:40 PM	50	81	164	169	168	173	170	194	169
12:50 PM	60	81	170	175	172	176	172	198	171
1:00 PM	70	81	173	177	175	180	174	200	173
1:10 PM	80	81	175	180	177	184	176	202	175
1:20 PM	90	81	176	182	177	185	178	203	176
1:30 PM	100	81	176	183	178	185	177	203	176
1:40 PM	110	81	176	180	177	186	177	202	176
1:50 PM	120	81	175	178	179	186	180	203	179
Reduce pump to 500 GPM @ 100 PSI and run for 10 minutes to confirm temperatures drop.									
2:00 PM	130	81	163	165	168	165	162	183	161

Conditions: 792 GPM, 250 PSI, 12.6 inHg, 195 HP, 2273 input RPM.

Actual Time	Time (Min)	Pit (°F)	#1 (°F)	#2 (°F)	#3 (°F)	#4 (°F)	#5 (°F)	#6 (°F)	#7 (°F)
2:10 PM	140	81	165	167	166	172	171	190	160
2:20 PM	150	81	169	177	171	182	177	201	176
2:30 PM	160	81	175	182	175	185	182	206	181

Conditions: 1500 GPM, 150 PSI, 17.0 inHg, 215 HP, 2110 input RPM.

Actual Time	Time (Min)	Pit (°F)	#1 (°F)	#2 (°F)	#3 (°F)	#4 (°F)	#5 (°F)	#6 (°F)	#7 (°F)
2:40 PM	170	81	179	186	178	190	182	206	184
2:50 PM	180	81	180	188	180	192	182	206	185
3:00 PM	190	80	181	189	181	195	183	207	187
3:10 PM	200	80	182	190	182	194	184	208	187
3:20 PM	210	80	183	191	183	194	184	208	188
3:30 PM	220	80	183	192	184	196	184	208	188

Summary of Outcome

The data shown above details multiple days of testing in order to determine optimum oil pump plumbing and correct oil level for the RSD-J series pump with a gearbox rotated to the right hand side. Up until this point the RSD-J has only been sold with a left hand gearbox and the right hand configuration was required to satisfy customer orders.

08-May-2014 (Evening) & 09-May-2014 (Morning)
Testing performed on these days was to gather baseline data for the pump as built per PL1202AC, with the only difference being a right hand gearbox instead of the standard left hand gearbox. The pump was built with a 016-5130-00-0 impeller and 016-1080-00-0 inducer. The standard 217-3370-00-0 sight gauge was used to determine the proper oil level and the pump gearbox was filled so the oil level was halfway in the sight gauge.

The pump was tested at 1320 GPM @ 150 PSI and 660 GPM @ 250 PSI. Testing in this configuration was performed in the evening and early morning when engineering was not present. Per the testers, multiple breather extensions were required to keep the pump from burping oil.

The test data obtained was very favourable with the exception of bearing #6, which was running consistently hotter than all other spots on the gearbox. This bearing in the gearbox is the particular bearing that absorbs the thrust load from the impeller and the thrust load from the helical gearbox gears so this bearing running at higher temperatures is to be expected.

14-May-2014 (Early AM and Morning)
Testing performed on this day was consistent with the gearbox configuration from 08-May-2014 with one minor change – the 217-3370-00-0 sight gauge was removed and replaced with a 1/2 NPT pipe elbow and plug to effectively raise the oil level in the gearbox by approximately one inch. This test was performed to determine if the bearings in the top of the gearbox struggle to get enough oil because the oil level in the gearbox sump is too low.

The pump was once again tested at 1320 GPM @ 150 PSI and 660 GPM @ 250 PSI. Overall the gearbox ran consistently hotter in all spots by approximately 20-25°F with the exception of bearing #6 running approximately 6-7°F cooler than the first test. This increase in observed temperatures was most likely due to the higher gearbox oil level, which did result in an addition of 9 HP from the original 08-May-2014 testing.

14-May-2014 (Evening)
Testing performed on this day included the use of a 1/2 NPT pipe elbow and plug to raise the oil level and additionally the oil pump plumbing was rerouted. Rather than having the oil pump feed line supply oil to the gearbox above the pump gear, the feed line was plumbed directly into the gearbox bearing cap to effectively flood the #6 bearing with oil. The re-plumbing of the oil pump feed line required the use of many breather extensions to keep oil from burping through the breather vent.

The pump was tested at 1320 GPM @ 150 PSI. The #6 bearing temperatures were slightly more favourable than the original test on 08-May-2014 after a period of 80 minutes. The water pit temperature was running 4°F warmer on 14-May-2014 so bearing temperatures were even more favourable due to this additional delta in temperature. However, bearing #6 is the only spot on the gearbox that saw improvement. All other bearings and the gearbox sump measured temperatures that were significantly higher than the 08-May-2014 testing and higher still than the temperatures observed in the early AM on 14-May-2014.

The increase in all bearing temperatures (with the exception of the lower temperature of bearing #6) was likely due to the oil being forced through the hottest spot on the gearbox before flowing through the rest of the gearbox case. The oil was effectively pulling a few degrees worth of heat out of the #6 bearing and taking that heat with it through the rest of the gearbox.

15-May-2014 (Morning)

Testing performed on this day was a continuation of testing performed 14-May-2014. The pump configuration remained the same and the pump was tested at 660 GPM @ 250 PSI. The pump exhibited the same characteristics as when it was tested at 1320 GPM @ 150 PSI with the exception of the overall temperatures being slightly cooler across the board.

15-May-2014 (Evening)

Testing performed on this day included the use of a 1/2 NPT pipe elbow and plug to raise the oil level, but the oil pump plumbing was reconfigured once again from the testing performed 14-May-2014. The use of the excessive breather extensions shown in the pictures from 14-May-2014 testing was not a good solution so a bypass hose with a pipe tee was added to the oil feed line. The purpose of the bypass hose was to allow some of the pressure from the oil pump to escape so oil would not burp out the breather.

The bypass hose solution worked as it allowed the use of only two pipe elbows connected to the breather vent. A clear hose was installed at one point to see how much oil actually moved through the bypass hose. Although no oil moved through the hose, the raised oil level could be seen in the clear hose and it was observed at approximately the same horizontal level as the base of the breather vent.

Although the bypass hose solution seemed to work, it was not a very clean configuration and continuing to pump oil directly into the #6 bearing made overall temperature results unfavourable as it caused the entire gearbox assembly to run hotter than desired.

After running the pump, the final oil level in the 1/2 NPT pipe elbow was checked to determine how much oil had burped out of the system. The oil level was approximately 1/2-5/8 inch below the top of the elbow, which places the oil level in the approximate location it would be in when using the 217-3370-00-0 sight gauge.

16-May-2014

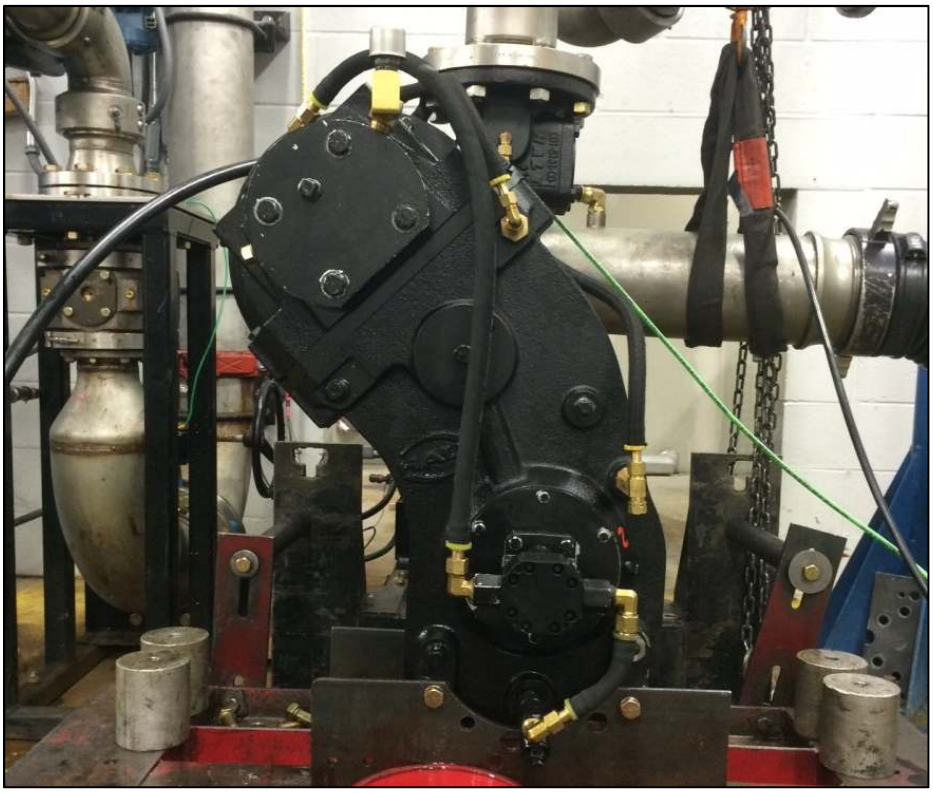
For the final day of testing, the pump configuration was returned to how it was built for the 08-May-2014 testing. The 217-3370-00-0 oil sight gauge was installed and the oil pump feed line was returned to the top of the gearbox. Two pipe elbows were used on the breather vent to help break oil bubbles and the gearbox was filled with oil to the halfway point of the sight gauge.

The pump was rebuilt with the 016-1050-00-0 impeller and 016-1080-00-0 inducer. The pump was tested at 1500 GPM @ 150 PSI and 215 HP was run through the gearbox. The pump was run for a total of 3:40 to ensure gearbox temperatures stabilized even at higher horsepower loads. The results were quite favourable with the #6 bearing running the hottest as previously observed but still well within the acceptable operating parameters (less than 225°F).

The final oil level was checked after running since initially some burping did occur through the breather vent. The oil level was observed at slightly above halfway on the sight gauge. The final oil quantity was measure at 1.75 quarts during removal of the pump from the test house.

Conclusion

Based upon test results, the original oil pump plumbing and oil level are optimum for the RSD-J pump when built with a right hand gearbox assembly (see below for final picture).



Although results were very favourable for 1500 GPM testing, additional testing is required before the pump can be rated at 1500 GPM or 6000 LPM (1585 GPM) to confirm the additional horsepower load will not cause any unforeseen issues with gearbox temperatures. Additional gearbox ratios will also need to be tested to confirm whether gearbox ratio and input speed have an effect on gearbox bearing temperatures.

At this time, it is recommended the RSD-J with right hand gearbox assembly be approved for use up to 5000 LPM (1320 GPM).