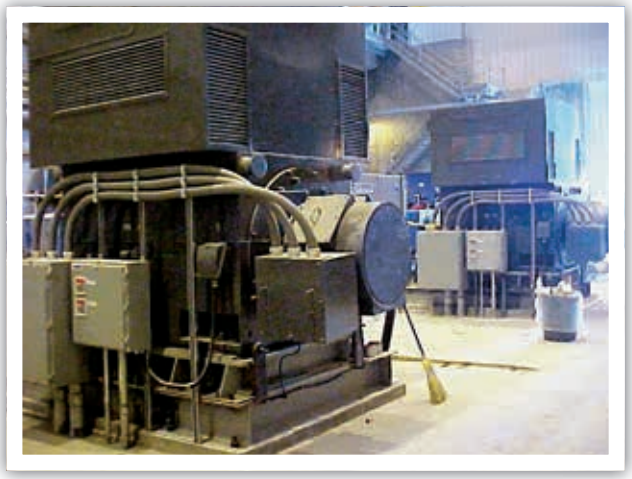
Synergy ENGINEERING LTD.

ENGINEERED SOLUTIONS for MATERIAL HANDLING

Secondary Resistance Controllers (SRC) *for* Pumping Applications



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Introduction

SYNERGY ENGINEERING LTD., known worldwide for overland conveyor drives systems, has now coupled its long-time proven Secondary Resistive Controller (SRC) technology with pumping applications resulting in the new Pump Drive SRC with variable speed capability. The new Pump Drive SRC is a fully self-contained and compact unit that can be easily integrated into an existing system or used as a stand-alone unit. Due to the compact design, installation time is minimized. Models of the Pump Drive SRC range from 300 HP to over 10,000 HP.

Secondary Resistive Controller (SRC) Background

The SRC is used for accelerating wound rotor induction motors (WRIM) for all types of applications. Essentially, the SRC controls the motor speed or torque through the programmed selection of binary-coded stainless steel resistors in the rotor circuit. For acceleration, the digitally-controlled binary-coded resistors provide precise control and optimum selection of typically 10-25 of 64-28 possible speed torque characteristics (depending on the specific application). For speed control, the typical efficient pumping range of the Pump Drive SRC is from 80-99% speed at 100% full load. The binary coded resistors provide a selection of 32-64 possible speed settings at full load using a speed feedback reference; however, accommodation for larger speed ranges is available. The digital control, stainless steel resistors, and high-speed vacuum contactors provide unsurpassed reliability and uncomplicated technology.

Benefits of a Pump Drive SRC

Some of the many benefits of using a Pump Drive SRC for controlled acceleration and speed control of a WRIM are reliability, efficiency, cost, and no harmonic generation.

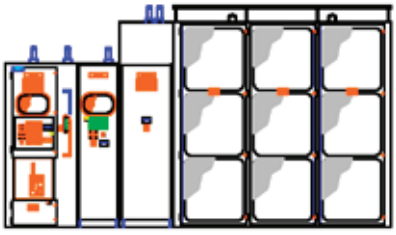
By combining the already proven technology of the SRC with our new theories and extensive engineering design, we have implemented the Pump Drive SRC to be one of the most reliable systems on the market with zero failures to date. We further ensure drive reliability by using computer modelling to determine the specific speed control characteristics. We also employ unique digital control technology to eliminate excessive torque transients during torque transitions between optimized speed-torque characteristics.

Maximum efficiency of the Pump Drive SRC is realized in part because there is no need for an isolation transformer. A step down transformer is also not required because the Pump Drive SRC may be applied equally to a 13.8 kV motor or a 4 kV motor of the same size, again increasing the system efficiency. The ability of the Pump Drive SRC to deliver up to breakdown torque to the driven load as required while still providing variable speed, makes the Pump Drive SRC a most effective drive.

Rather than rely on frequency manipulation to

vary speed, the Pump Drive SRC switches stainless steel resistors in and out of the rotor circuit using high-speed vacuum contactors. This results in a harmonic free system eliminating the need for internal or external harmonic filtering.

Overall, the Pump Drive SRC proves to be less costly than other pump drive options. The elimination of harmonic filtering or a step down transformer for a 13.8 kV feed further reduces the cost of the Pump Drive SRC. Although no failures have yet been recorded, if an electrical component fails it may easily be replaced by any site electrician. This eliminates the need for costly systems specialists, keeping maintenance costs to a minimum.



Made to Order

Each Pump Drive SRC is designed specifically to meet the requirements for each situation. This includes application-specific speed control and acceleration programmes, as well as application-specific specially designed dual-purpose stainless steel resistor grids used for acceleration and continuous speed control. Given the pump characteristics and operating requirements, standard delivery times on smaller units are only 4-6 weeks. The Pump Drive SRC in the above photo is shown with a 15 kV, SF6 circuit breaker for motor starting.

Successful Application in Industry

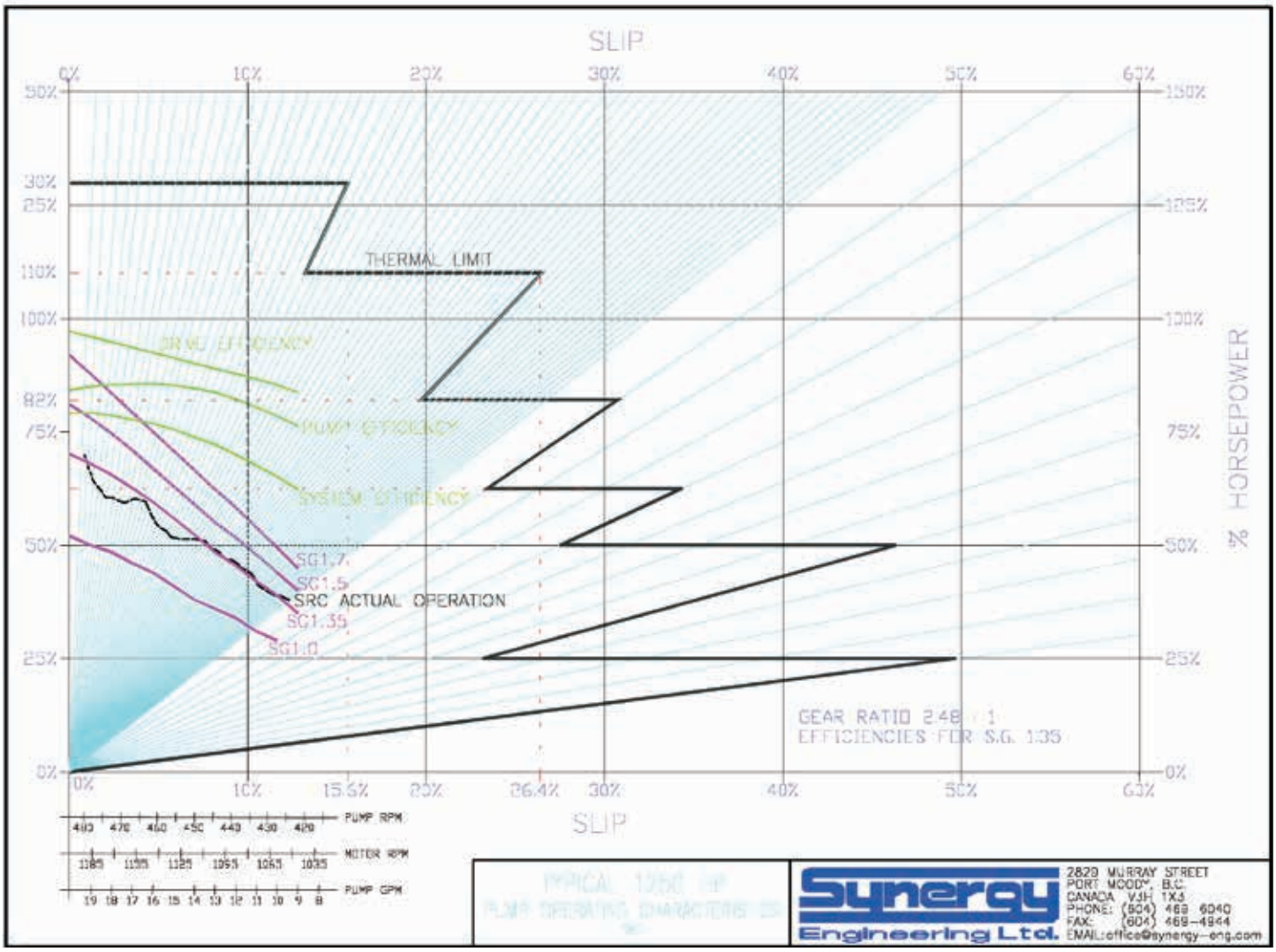
Successful application of our Pump Drive SRC can be viewed at Highland Valley Copper, a copper mine located just outside of Logan Lake in the interior of British Columbia. Currently Highland Valley Copper is using six of our Pump Drive SRCs, replacing six older variable frequency drives. Each Pump Drive SRC drives a 1250 HP, 13.8 kV, 60 Hz, 6-pole WRIM each turning an 18x20 pump with a 41.25" impeller used for pumping slurry. By utilizing nine starting resistors, six of which are used for continuous speed control, the Pump Drive SRC is capable of providing continuous speed control in the range of 62.5-99.0%. This is accomplished by using 64 torque versus slip characteristics in 0.5% increments. The Pump Drive SRC can be controlled by the central pump house PLC, by a remote station in the pump room, or by the Pump Drive SRC itself. This includes starting, stopping, and speed control.

The human-machine-interface (HMI) display unit is mounted on the Pump Drive SRC door. By using the stator current, pump speed, flow rate, and motor speed are calculated. These values, along with other useful information such as alarming and logged operation hours, are displayed on the HMI. The integrated and pre-cabled units required minimum installation and commissioning time; each unit was installed, cabled, and communicating with central pump house PLC within two days.

Field Testing

The following page shows a graph of the start-up and speed control characteristics of the Pump Drive SRC at Highland Valley Copper. Also included is a data chart of the Pump Drive SRC in operation. The motor is a 1250 HP, 13.8 kV, 60 Hz, 6-pole WRIM and is driving an 18x20" pump with a 41.25" impeller.

Secondary Resistive Controllers (SRC) for Pumping Applications, continued



STEP	MOTOR SPEED (rpm)	PUMP SPEED (rpm)	BOX LEVEL (%)	AVG. PRI. CURRENT, (A)	TORQUE (p.u.)	SEC. CURRENT phase A, (A)	FLOW (gpm* 1000)
64	1190.0	479.8	86.4	37.2	0.6992	466.7	19.3
63	1184.1	477.5	86.2	34.2	0.6421	466.7	18.9
62	1179.5	475.6	85.9	33.2	0.6233	473.8	18.6
61	1175.4	474.0	85.7	32.2	0.6046	466.7	18.3
60	1171.4	472.3	85.2	32.2	0.6046	424.3	18.0
59	1166.2	470.2	85.6	31.8	0.5971	424.3	17.6
58	1162.6	468.8	85.8	31.2	0.5858	420.7	17.3
57	1156.6	466.4	85.9	32.2	0.6046	410.1	16.9
56	1155.1	465.8	86.3	32.8	0.6024	417.2	16.8
55	1148.9	463.3	86.0	32.8	0.6024	403.1	16.4
54	1147.3	462.6	85.9	31.8	0.5841	403.1	16.2
53	1144.3	461.4	85.9	30.7	0.5639	367.7	16.0

Secondary Resistive Controllers (SRC) for Pumping Applications, continued

STEP	MOTOR SPEED (rpm)	PUMP SPEED (rpm)	BOX LEVEL (%)	AVG. PRI. CURRENT, (A)	TORQUE (p.u.)	SEC. CURRENT phase A, (A)	FLOW (gpm* 1000)
52	1141.5	460.3	85.8	29.7	0.5455	360.6	15.8
51	1136.7	458.3	85.8	29.7	0.5334	350.0	15.5
50	1134.9	457.6	85.7	29.7	0.5334	342.9	15.4
49	1131.8	456.4	85.7	28.7	0.5184	332.3	15.1
48	1132.6	456.7	85.7	28.7	0.5184	328.8	15.2
47	1127.9	454.8	85.7	28.7	0.5154	321.7	14.9
46	1122.0	452.4	85.9	28.7	0.5125	314.7	14.4
45	1114.9	449.6	86.2	29.7	0.5273	314.7	13.9
44	1112.4	448.5	86.1	29.7	0.5273	314.7	13.7
43	1101.3	444.1	85.9	28.7	0.5096	300.5	12.9
42	1108.7	447.1	85.8	28.7	0.5096	293.4	13.5
41	1103.9	445.1	85.7	27.6	0.4900	282.8	13.1
40	1104.6	445.4	85.6	27.6	0.4900	282.8	13.2
39	1102.1	444.4	85.7	27.6	0.4900	272.2	13.0
38	1099.0	443.1	85.7	27.6	0.4844	268.7	12.8
37	1096.0	441.9	85.9	26.7	0.4686	261.6	12.6
36	1087.9	438.7	86.1	27.6	0.4844	261.6	12.0
35	1086.5	438.1	85.7	27.6	0.4844	258.1	11.9
34	1092.7	440.6	85.8	26.7	0.4686	247.5	12.3
33	1086.3	438.0	85.7	26.7	0.4686	244.0	11.9
32	1094.0	441.1	85.6	26.7	0.4686	251.0	12.4
31	1091.8	440.2	85.4	26.7	0.4686	244.0	12.3
30	1088.5	438.9	85.5	26.7	0.4686	236.9	12.0
29	1085.6	437.7	85.3	25.6	0.4493	233.3	11.8
28	1084.1	437.1	85.1	25.6	0.4493	231.9	11.7
27	1077.4	434.4	85.4	25.6	0.4389	226.3	11.2
26	1076.8	434.2	85.5	25.6	0.4389	224.9	11.2
25	1074.3	433.2	85.5	25.6	0.4389	218.5	11.0
24	1073.6	432.9	85.7	25.6	0.4389	217.1	11.0
23	1074.2	433.1	85.5	24.6	0.4217	210.7	11.0
22	1053.4	424.8	85.6	24.6	0.4217	206.5	9.5
21	1054.7	425.3	85.6	26.7	0.4577	211.4	9.6
20	1048.3	422.7	85.7	25.6	0.4389	205.1	9.1
19	1058.4	426.8	85.2	23.6	0.4046	194.5	9.9
18	1053.4	424.8	85.5	24.6	0.4217	194.5	9.5
17	1057.5	426.4	85.7	24.6	0.4217	194.5	9.8
16	1065.2	429.5	79.7	24.6	0.3765	194.5	10.4
15	1071.7	432.1	76.2	23.6	0.3612	182.4	10.8
14	1074.1	433.1	68.5	23.6	0.3612	178.2	11.0
13	1076.6	434.1	61.9	22.6	0.3459	176.1	11.2
12	1061.6	428.1	85.6	23.1	0.3771	176.8	10.1

Secondary Resistive Controllers (SRC) for Pumping Applications, continued

STEP	MOTOR SPEED (rpm)	PUMP SPEED (rpm)	BOX LEVEL (%)	AVG. PRI. CURRENT, (A)	TORQUE (p.u.)	SEC. CURRENT phase A, (A)	FLOW (gpm* 1000)
11	1063.6	428.9	84.9	22.6	0.3644	172.5	10.2
10	1061.8	428.1	81.4	22.6	0.3644	166.2	10.1
9	1053.9	425.0	85.2	22.6	0.3598	169.0	9.5
8	1049.2	423.1	85.9	23.6	0.3709	169.7	9.2
7	1046.7	422.1	85.7	23.6	0.3660	169.0	9.0
6	1044.3	421.1	85.7	23.6	0.3612	166.2	8.9
5	1041.5	420.0	86.2	23.6	0.3564	164.8	8.7
4	1039.2	419.0	85.7	23.6	0.3516	162.6	8.5
3	1036.0	417.7	86.4	22.6	0.3321	159.8	8.3
2	1032.4	416.3	86.8	22.6	0.3275	159.1	8.0
1	1031.4	415.9	85.7	22.6	0.3229	157.7	7.9

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