Evaluation of Cordless Drills when used as DC Generators

(9 May 05)

In looking for the efficiency and maximum voltage and power available from cordless drills used as DC generators the following measurements were preformed.

One drill was powered to turning another of the same type hooked up as a generator. There was a short bolt put in the chuck of each unit to mechanically tie them together. Both were turning at the same speed.

Several conditions were measured. The input current and voltage used under no load as a single drill was measured. The input current and voltage was measured while tuning another drill under no load was measured. Then the input current and voltage was measured while tuning another drill while generating output power was measured.

From these measurements the efficiency of each type of unit was then determined. See the attached table for a summary of the average measurements and calculated results. http://home1.gte.net/mikelob/Drill_Measurments.htm

Type of Test	# of Drills	Input volts	Input Current	Input Power	Output Volts	Output Current	Output power
	500 RPM						
12 volt drill	max				3 cells		
Off OC	0.00	13.37	0.00	0.00	4.10	0.00	0.00
No load	1.00	12.30	1.65	20.23	0.00	0.00	0.00
Open Circuit	2.00	11.87	3.60	42.68	8.73	0.00	0.00
Generating	2.00	11.05	7.42	81.99	5.32	2.50	13.30
	550 RPM						
14 Volt drill	max				4 Cells		
Off OC	0.00	15.46	0.00	0.00	5.46	0.00	0.00
No load	1.00	15.50	1.17	18.14	0.00	0.00	0.00
Open Circuit	2.00	14.26	2.14	30.52	11.40	0.00	0.00
Generating	2.00	12.75	6.94	88.42	7.09	3.13	22.16
	900 RPM						
18 Volt drill	max				4 Cells		
Off OC	0.00	20.20	0.00	0.00	5.46	0.00	0.00
No load	1.00	19.20	1.81	34.75	0.00	0.00	0.00
Open Circuit	2.00	18.60	4.81	89.47	15.40	0.00	0.00
Generating	2.00	17.25	11.89	205.10	8.12	5.13	41.62

Output Power	Power Losses	Percentages	Results and Description
12 volt drill	20.97	0.44	average /drill gear train power loss
	13.37	0.28	average /drill electrical power loss
		0.28	efficiency generating at max speed
14.4 Volt drill	16.22	0.29	average /drill gear train power loss
	16.92	0.31	average /drill electrical power loss
		0.40	efficiency generating at max speed

18 Volt drill	41.41	0.34	average /drill gear train power loss
	40.34	0.33	average /drill electrical power loss
		0.34	efficiency generating at max speed

Summary of the results:
12, 14.4, and 18 Volt drills at rated speed output a maximum of 8.7, 11.4, and 15.4 open circuit Volts. This is to say the output voltage is roughly 74, 80, and 83 percent of the input volts when acting as a motor generator set. The suggested maximum rated output generated power at rated speeds of 500, 550, and 900 is 13.3, 22.2, and 41.6 watts. The electrical output generating efficiency is about 28, 40 and 34 percentage of the total input power. This to say that the 14.4 Volt drill is slightly more efficient at generating power than the other two.

Rules of thumb or lessons learned from current experience:

When generating optimum maximum output power plan on an output voltage of no higher than half the drills rated input voltage. Use 2 drills in series when planning to generate near to the rated input voltage for the given drills.

I don't recommend running any unit faster than it was designed to run originally. Rated speed for 12 volt unit is 500 RPM, 14.4 volt unit is 550 RPM, and 18 volt unit is 900 RPM. I have noted that one gets about 80 percentage of the input voltage as output open circuit voltage when acting as a generator at rated maximum speed. Use this as a guide to make sure your design doesn't end up going too fast.

It's hard to say what the maximum sustained current capability of these units is. My best current guess is about 3-4 amps for 12 volt, 3-4 amps for 14.4 volt and 4-5 amps for the 18 volt unit. The short term surge max can be twice the current in the previous sentence. Plan on using no higher sustained output power than 13, 22, and 41 watts for 12, 14.4 and 18 volt tested individual drills.

Turning the unit at faster than rated speed could ware out the gears and bushings before there time and is not recommended. The electrical components are not designed for voltage much above the rated input voltage. Also, there is a strong possibility of thoroughing a bar on the commentator of the motor due to centrifugal force and heat. This happened on one test run where it was generating into a heavy load at more than twice the rated voltage.

Output efficiency is about 30 to 40 percent of input power. The rest of the input power goes to gear friction and electrical losses as heat.

The 14.4 volt cordless drill is the current best unit for hand cranking because of it's higher efficiency and high volts/RPM ratio. This would hold true for water power also. For bicycle pedal powered cranking the 14.4 volt and 18 volt both will work. I favor slightly the 14.4 volt unit however the 18 volt unit might just make up for this by lasting longer.

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On the bicycle generator if you find the power wildly surging with every half turn of the pedals, then chances are the drill drive wheel is too small and the pedaling needs to be made easer. One can also add weight or make a flywheel effect out of the bicycle wheel but this is not recommended due to possibly causing other things to ware out quicker.

For bike and water wheel applications feel the temperature of the generator from time to time by sticking your finger into the open slot where the trigger switch was to feel the metal case of the motor. Cut down on your output power if it is getting hot. The estimated maximum allowable power output for the 2 drill series combination is twice the above recommendation or 26, 44, and 82 watts.

Be sure to use a one way rectifier diode in series with the unmodified cordless drill when taping closed the trigger switch to make a DC generator. Use a diode in preference to converting the internal 3 wire component to a diode. I don't have much trust in this component.

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