Technical article

Dual fuel ovens: best of both worlds

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THE origins of Sicme Italia Impianti Srl are well established: ours is a company that has always been heavily involved in research and development in the field of copper wire insulation for electro-technical applications.

A brief history: the first enamelling oven was produced by Sicme in 1959 to test new insulating enamels produced by the chemical industry – enamels which quickly superceded the oleoresinous types then in use.

The experience gained during the fine-tuning of this first oven enabled valuable parameters to be established that became standard in oven specification – three heat chambers, with different heat temperatures; a preheating zone, and an evaporation and polymerisation zone. These remain the key characteristics of any enamelling oven today.

A new design of enamelling ovens, ones that pushed hot air in the opposite direction of the wire travel, was another innovation that promoted greater, more consistent production.

Later, the introduction of catalysts also considerably reduced the level of pollution, while new oven designs – with recirculated air and highly controlled and reduced thermal consumption – offered further improvements.

The use of thermal insulation resulted in even greater energy savings and in turn offered greater efficiency, as did the introduction of automatic spool changeover and inline drawing.

Both Sicme and Sicme Italia Impianti focused on these key drivers of change and by 2000 it was generally believed energy consumption had been optimised.

But these were all electrically-powered overn designs. What of gas?

Enamel wire manufacturing using natural gas for heating was first promoted by Sicme technicians in 1978, and the company built 40 natural gas ovens which operated at Superior Essex, Rea Magnet Wire, Lackdraht Union and other companies around the world. Some remain operational today - and still offer good energy consumption!

Which brings us to the current state of the art; new super-compact gas machines developed by Sicme Italia Impianti and able to run either on natural gas or electricity, and in horizontal or vertical format.

Select electric power and the oven operates like a conventional, single-line compact machine and guarantees a VxD of 180-190, with power consumption comparable to other sophisticated modern machines. Operational complexity is no greater than for comparable models.

C160

IEC	AWG	COPPER						ALUMINIUM					
		PEI Grade 1		PU Grade 1		Usage		PEI Grade 1		PU Grade 1		Usage	
[mm]	[---]	[m/min]	hourly [kg]	[m/min]	hourly [kg]	PEI	PU	[m/min]	hourly [kg]	[m/min]	hourly [kg]	PEI	PU
						Kwh/kg						Kwh/kg	
0,160	34	994	10,7	1000	10,7	1,80	1,70	-	-	-	-	-	-
0,180	33	872	11,8	882	12,0	1,60	1,50	-	-	-	-	-	-
0,200	32	770	12,9	785	13,2	1,40	1,30	-	-	-	-	-	-
0,224	31	674	14,2	688	14,5	1,20	1,10	-	-	-	-	-	-
0,250	30	596	15,6	608	15,9	1,00	0,90	472	3,7	500	4,0	2,7	2,6
0,280	29	525	17,3	536	17,6	0,80	0,70	418	4,2	443	4,4	2,6	2,5
0,315	28	460	19,1	470	19,5	0,70	0,60	368	4,6	390	4,9	2,4	2,3
0,355	27	-	-	-	-	-	-	324	5,2	344	5,5	2,2	2,1
0,400	26	-	-	-	-	-	-	285	5,8	303	6,1	2,0	1,9
0,450	25	-	-	-	-	-	-	249	6,4	264	6,8	1,7	1,6
0,500	24	-	-	-	-	-	-	220	7,0	234	7,4	1,4	1,3
0,560	23	-	-	-	-	-	-	193	7,7	205	8,1	1,1	1,0

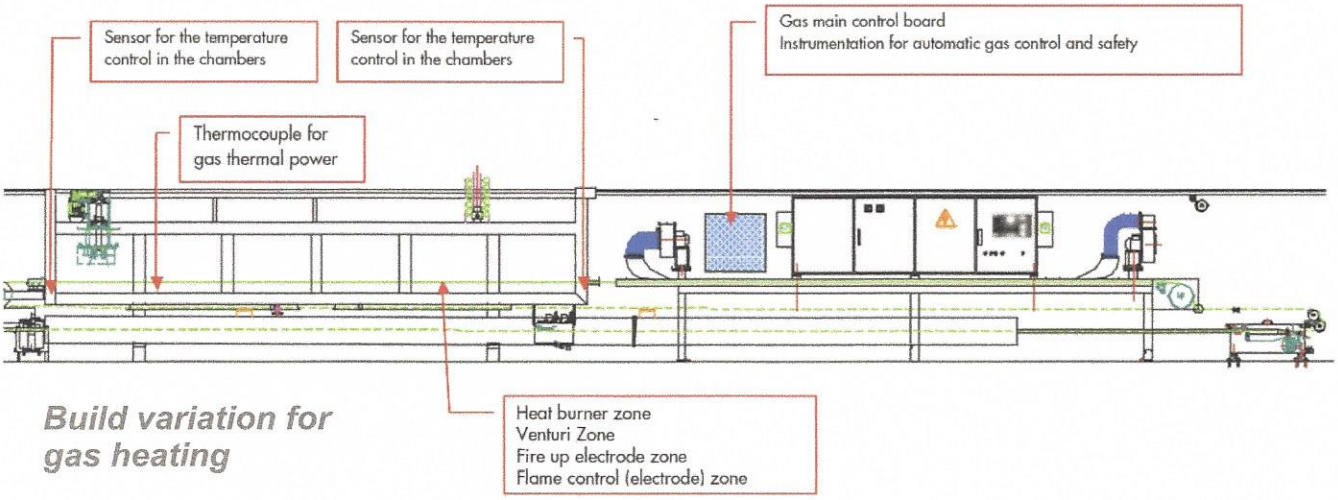
Tests using standard heating (upper) and super-compact gas heating (lower)

SC.160

IEC	AWG	COPPER						ALUMINIUM					
		PEI Grade 1		PU Grade 1		Usage		PEI Grade 1		PU Grade 1		Usage	
[mm]	[---]	[m/min]	hourly [kg]	[m/min]	hourly [kg]	PEI	PU	[m/min]	hourly [kg]	[m/min]	hourly [kg]	PEI	PU
						m^3/kg						m^3/kg	
0,160	34	1243	13,3	1250	13,4	0,16	0,16	-	-	-	-	-	-
0,180	33	1090	14,8	1103	15,0	0,14	0,14	-	-	-	-	-	-
0,200	32	963	16,1	981	16,5	0,13	0,13	-	-	-	-	-	-
0,224	31	843	17,7	860	18,1	0,12	0,12	-	-	-	-	-	-
0,250	30	745	19,5	760	19,9	0,11	0,11	566	4,5	600	4,8	0,5	0,4
0,280	29	656	21,6	670	22,0	0,10	0,10	502	5,0	532	5,3	0,4	0,4
0,315	28	575	23,9	588	24,4	0,09	0,09	442	5,6	468	5,9	0,4	0,4
0,355	27	-	-	-	-	-	-	389	6,2	413	6,6	0,3	0,3
0,400	26	-	-	-	-	-	-	342	6,9	364	7,4	0,3	0,3
0,450	25	-	-	-	-	-	-	299	7,7	317	8,1	0,3	0,3
0,500	24	-	-	-	-	-	-	264	8,4	281	8,9	0,3	0,2
0,560	23	-	-	-	-	-	-	232	9,2	246	9,8	0,2	0,2

Sicme production line

Super-compact gas horizontal wire enamelling machine



Build variation for gas heating

Select gas power and operationally, nothing changes: string-up is the same as for electric power and when the oven temperature has been reached, the applicator fills with enamel and production starts as expected.

After establishing operational parameters on first set up (wire diameter, enamel type, oven operating temperature and so on) the requirements can be repeated automatically, and to the same laboratory test results.

In slightly greater depth (this development is subject to a patent application), the catalytic zone has been modified with material resistant to the abrasiveness of the very high temperature flame.

The geometry has also been modified so performance doesn't alter when the oven fuel is changed.

Each line features its own gas supply for thermal power, and this features an electrovalve counter, a pressure reducer, a micro-volumetric pump for gas and ambient air, and all the necessary control and safety mechanisms, including extra sensors. The unique burner design is also patented.

With each system comes specially-tailored software that enables easy operation.

Any experienced operator is generally able to start using the super compact G machines immediately.

Test machines in operation at Sicme partner De Angeli Prodotti Srl were thoroughly tested for 15 days under laboratory conditions to check consumption, speed and quality of production and resulting pollution.

The results in the graphs here are from those tests.

De Angeli currently has these machines running two lines each at full production for aluminium and copper wires.

As you can see from the results and costings, at current prices gas heating significantly beats electricity – to the extent that producing a tonne of aluminium wire with gas costs only 46 per cent of the cost with electricity

Production cost

(assuming common raw materials costs - in Italy electricity €0.12, gas €0.35)

Cost of one tonne, aluminium grade one, diameter 0.28mm

High speed electric		*Super-Compact gas*
124	VxD	149
4.4kg	Hourly production rate	5.3kg
2,500kW	Thermal consumption per 1,000kg	400m³ (methane)
227hr	Time to produce 1,000kg	188hr
€300	**Cost of 1000kg**	**€140**

C300

IEC	AWG	COPPER						ALUMINIUM					
		PEI Grade 1		PU Grade 1		Usage		PEI Grade 1		PU Grade 1		Usage	
[mm]	[—]	[m/min]	hourly [kg]	[m/min]	hourly [kg]	PEI Kwh/kg	PU Kwh/kg	[m/min]	hourly [kg]	[m/min]	hourly [kg]	PEI Kwh/kg	PU Kwh/kg
0,355	27	558	29,5	580	30,6	0,58	0,56	-	-	-	-	-	-
0,4	26	490	32,9	510	34,2	0,56	0,54	-	-	-	-	-	-
0,45	25	431	36,6	449	38,1	0,54	52	-	-	-	-	-	-
0,5	24	384	40,2	400	41,9	0,52	0,50	304	9,6	318	10,1	1,3	1,25
0,56	23	339	44,6	352	46,3	0,51	0,49	268	10,7	280	11,1	1,25	1,2
0,63	22	298	49,6	310	51,6	0,50	0,48	235	11,8	246	12,4	1,15	1,1
0,71	21	262	55,4	272	57,5	0,48	0,46	206	13,2	215	13,7	1,1	1,05
0,8	20	229	61,4	238	63,9	0,46	0,44	180	14,6	189	15,3	0,95	0,92
0,9	19	-	-	-	-	-	-	150	15,4	158	16,2	0,9	0,86
1,00	18	-	-	-	-	-	-	132	16,7	140	17,7	0,85	0,83
1,25	17	-	-	-	-	-	-	103	20,4	110	21,8	0,8	0,78

Tests using standard heating (upper) and super-compact gas heating (lower)

SC.300

IEC	AWG	COPPER						ALUMINIUM					
		PEI Grade 1		PU Grade 1		Usage		PEI Grade 1		PU Grade 1		Usage	
[mm]	[—]	[m/min]	hourly [kg]	[m/min]	hourly [kg]	PEI m³/kg	PU m³/kg	[m/min]	hourly [kg]	[m/min]	hourly [kg]	PEI m³/kg	PU m³/kg
0,355	27	670	35,4	696	36,8	0,06	0,06	-	-	-	-	-	-
0,4	26	588	39,4	612	41,0	0,05	0,05	-	-	-	-	-	-
0,45	25	517	43,9	539	45,7	0,05	0,05	-	-	-	-	-	-
0,5	24	461	48,3	480	50,3	0,04	0,04	365	11,6	382	12,1	0,18	0,17
0,56	23	407	53,5	422	55,5	0,04	0,04	322	12,8	336	13,4	0,16	0,16
0,63	22	358	59,5	372	61,9	0,04	0,03	282	14,2	295	14,8	0,15	0,14
0,71	21	314	66,4	326	69,0	0,03	0,03	247	15,8	258	16,5	0,13	0,13
0,8	20	275	73,7	286	76,6	0,03	0,03	216	17,5	227	18,4	0,12	0,11
0,9	19	-	-	-	-	-	-	180	18,5	190	19,5	0,11	0,11
1,00	18	-	-	-	-	-	-	158	20,1	168	21,3	0,1	0,1
1,25	17	-	-	-	-	-	-	124	24,5	132	26,1	0,09	0,08