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ELECTRICAL INSTALLATION RELATED TO AGRO-INDUSTRIAL-SEA BUCKTHORN UNITS

BY

ŞTEFAN PAVEL[1,*], EMILIA DOBRIN[2] and BOGDAN PASCU[1]

[1]University Politehnica Timişoara – ICER,
[2]S.C.AEM SA Timişoara

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Abstract. At a first glance, the electrical installations of the agro-industrial units are simple to conceive, designed or executed, but after a careful analysis we find that there is a need of multiple technical knowledge of electrical installations for constructions with extensive and complex calculations.

Keywords: electrical installation; agro-industrial unit; sea buckthorn.

1. Introduction

Sea buckthorn is appreciated for its qualities in the field of food industry, silviculture and pharmacy, it represents a cost-effective plant to be cultivated, a true romanian gingseng. The agro-industrial units destined for taking over, conditioning and marketing of the sea buckthorn, are economical units which can bring a profit of 10.000 euros/ha or up to 500.000 euros/year (estimates for 2017-2018). From the point of view of electrical installations for agro-industrial constructions, these are mentioned in the I7/2011 indicative of

[*]Corresponding author: *e-mail:* pavelstefanel@gmail.com

the „Monitorul Oficial al Romaniei", partea I, Nr.802 bis/14.XI.2011, cap.7, pct.7.5. Agro-industrial and agrozootechnical constructions include:

– Buildings in which agricultural products are prepared...;

– Barns, warehouses and deposits for fruits...;

– Housing and other sites belonging to the agro-industrial and agro-zootechnical constructions (offices, workshops, garages, shops).

In this material it is presented the electrical installation for a agro-industrial unit, destined for taking over, conditioning and marketing of the sea buckthorn with the following planned dimensions:

– Hall: 18.01 × 30.50 × 6.69 m, S = 549 m^2;

– Annex: 11.90 × 13.10 × 5.57 m, S = 155.89 m^2.

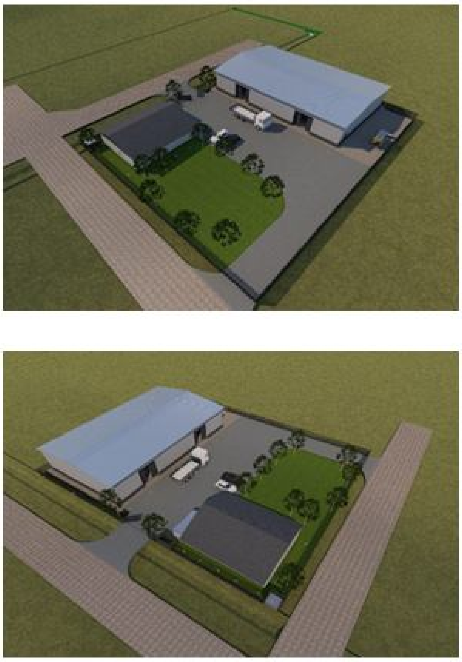

Fig. 1 – The proposed architecture for an agro-industrial, agrozootechnic unit destined for taking over, conditioning and marketing of the sea buckthorn.

For a more accurate calculation of the electrical parameters, the power consumption of all the electric receivers are needed. From a theoretical point of view, the beneficiary is obliged to hand over to the electrical designer, a list of all the electric receivers that will operate in that location. In practice, it has been proven that they don't possess the technical knowledge, thus resulting that the entire responsibility in making the list of the electric receivers falls on the electrical design engineer.

In Table 1 and Table 2 are mentioned the single phase and three phase electric receivers.

Table 1
Single Phase Receivers

No.	Electric receivers	Type	Single phase electric receivers (1-230 V c.a.)			
			Power factor (cosφ)	Starting factor	Absorbed power (nom.W)	Quantity
			1	2	3	4
1.	Aquarium	Inductive	0.50	1.00	200	
2.	Air conditioning unit	Inductive	0.80	2.00	2,000	
3.	Inverter welding machine	Inductive	0.70	2.00		
4.	Transformer welding machine	Inductive	0.50	2.00		
5.	Electric stove	Resistive	1.00	1.00	3,000	
6.	Vacuum cleaner	Inductive	0.80	2.00	2,000	
7.	Incandescent matte bulbs	Resistive	1.00	1.00	1,200	
8.	Compact fluorescent bulb	Inductive	0.50	1.00	500	
9.	Clear incandescent bulb	Resistive	1.00	1.00		
10.	Incandescent matte bulb	Resistive	1.00	1.00		
11.	Cement mixers	Inductive	0.80	2.00		
12.	Electric drill	Inductive	0.80	2.00	800	1
13.	CD/cassette boombox	Inductive	0.70	1.00	75	
14.	Computers	Inductive	0.70	1.00	400	2
15.	Compressors	Inductive	0.80	2.00		
16.	Microwave oven	Inductive	0.70	1.00	1,700	1
17.	Electric water heater	Resistive	1.00	1.00	2,000	1
18.	Electric kettle (2 l.)	Resistive	1.00	1.00	1,700	
19.	Wi fi	Inductive	0.70	1.00	600	
20.	Freezer (350 l)	Inductive	0.80	2.00		
21.	New Freezer (250 l)	Inductive	0.80	2.00	300	1
22.	Old Freezer (250 l)	Inductive	0.80	2.00		
23.	Electric oven	Resistive	1.00	1.00	2,000	1
24.	Rotary hammers	Inductive	0.80	1.50	1,200	
25.	Professional photo-video equipment	Inductive	0.70	1.00		
26.	Coffee machine (2 l)	Resistive	1.00	1.00	1,700	1

Table 1
Continuation

No.	Electric receivers		Type	Single phase electric receivers (1-230 V c.a.)			
				Power factor (cosφ)	Starting factor	Absorbed power (nom.W)	Quantity
				1	2	3	4
27.	Refrigerator, refrigerated showcases		Inductive	0,80	2.00	500	1
28.	Iron		Resistive	1.00	1.00	1,200	
29.	Absorption refrigerator		Resistive	1.00	1.00		
30.	Refrigerator with compressor and thermostat (200l)		Inductive	0.80	2.00		
31.	Convertible Range Hood		Inductive	0.80	2.00	70	
32.	Recorder		Inductive	0.70	1.00		
33.	Automatic washing machine	Motor	Inductive	0.80	2.00	2,000	1
		Resistance	Resistive	1.00	1.00		
34.	Sound system		Inductive	0.70	1.00	500	
35.	Polypropylene soldering machines		Resistive	1.00	1.00		
36.	Stationary machines (grinders,drills,lathes, saw ,etc.)		Inductive	0.80	2.00	500	
37.	Sewing machine		Inductive	0.80	2.00	250	
38.	Washing machine – with water heater	Motor	Inductive	0.80	2.00		
		Resistance	Resistive	1.00	1.00		
39.	Washing machine		Inductive	0.80	2.00		
40.	Dishwasher	Motor	Inductive	0.80	2.00	2,000	
		Resistance	Resistive	1.00	1.00		
41.	Mixer		Inductive	0.80	2.00	100	
42.	Neons(Fluorescent tubes),economical light bulbs,mercury vapor light bulbs		Inductive	0.50	1.00	160	
43.	Water bed		Inductive	0.50	1.00		
44.	Straight and angle grinders, drills		Inductive	0.80	1.50		
45.	Hydrophore pumps		Inductive	0.80	2.00	1,700	2
46.	Centrifugal pump		Inductive	0.80	2.00		

Table 1
Continuation

No.	Electric receivers		Type	Single phase electric receivers (1-230 V c.a.)			
				Power factor ($\cos\varphi$)	Starting factor	Absorbed power (nom.W)	Quantity
				1	2	3	4
47.	Hot air blowers		Resistive	1.00	1.00	2,000-	5
						3,000	5
48.	Bread toaster		Resistive	1.00	1.00	900	
49.	TVs		Inductive	0.70	1.00	70	2
50.	Hairdryer	Motor	Inductive	0.80	2.00	1,400	1
		Resistance	Resistive	1.00	1.00		
51.	Clothes dryer	Motor	Inductive	0.80	2.00		
		Resistance	Resistive	1.00	1.00		
52.	Kitchen fan		Inductive	0.80	2.00	50	
53.	Video		Inductive	0.70	1.00	50	
54.	Car acces gate		Inductive	0.80	2.00	700	2
55.	Sliding garage door		Inductive	0.80	2.00		

Totally illuminated = 1,012 Watt;
Total receivers = 43,140 Watt;
Total = 44,152 Watt = 44.12 kW.
Maximum absorbed power (VA) computed according to the following formula expressed in terms of values presented in the columns 1 … 4 from Table 1 = (3/1) × 2 × 4

Table 2
Three Phase Receivers

01.	Three phase plugs	2,000	2
02.	Sea buckthorn threshing machine	20,000	1

Observations:
Special electrical equipment: *Refrigeration unit 1:* 1 × 42.00 kW;
Special electrical equipment: *Refrigeration unit 2:* 1 × 20.00 kW;
Total three phase receivers = 80.5 kW.
The total of the electric receivers is 128,122 kW + a reserve of 10 kW = = 138.12 kW.

The energy balance for the entire agroindustrial-sea buckthorn unit contains the following calculus elements (Manualul instalațiilor electrice, 2007):

- Installed power [kW] = 138 (with a reserve of 10kW)
- Coefficient of demand, Kc = 0.7
- $\cos\varphi = 0.8$;

- cos φmed. = 0.8;
- Required power [kW] = 96.6;
- The calculus current, Ic = 146.94 A;
- The maximum admissible calculus current, Ima = 183.68 A;
- Section of the conductor Cu = 120 mm^2; (cable CYABY-F 3x120+70);
- Voltage drop, ΔU = 0.21%;
- Nominal current of fuse, Inf = 200 A.

The energy balance for Hall – SPACE FOR TAKING OVER, CONDITIONING AND MARKETING OF THE SEA BUCKTHORN (Manualul instalațiilor electrice, 2007):

- Installed power [kW] = 85;
- Coefficient of demand, Kc = 0,7;
- cos φ = 0,8;
- cos φmed. = 0,8;
- Required power [kW] = 66,5;
- The calculus current, Ic = 101,16A;
- The maximum admissible calculus current, Ima = 126,45A;
- Section of the conductor Cu = 70mm^2; (cable CYABY-F 3 × 70 + 35);
- Voltage drop, ΔU = 0.17%;
- Nominal current of fuse, Inf = 125 A.

The energy balance for *ANNEX* (Manualul instalațiilor electrice, 2007):

- Installed power [kW] = 43,14;
- Coefficient of demand, Kc = 0,5;
- cos φ = 0,8;
- cos φmed. = 0.8;
- Required power [kW] = 30.2;
- The calculus current, Ic = 45.94 A;
- The maximum admissible calculus current, Ima = 57.43A;
- Section of the conductor Cu = 16 mm^2; (cable CYABY-F 5 × 16);
- Voltage drop, ΔU = 0.42%;
- Nominal current of fuse, Inf = 125 A.

The special equipment *THRESHING MACHINE* is equipped with an electric motor, the calculus elements are presented in Table 3 (Indreptar pentru autorizarea electricienilor, instalații de utilizare până la 1000 V, 1969).

The special equipment *REFRIGERATION UNIT 1* is equipped with an electric motor, the calculus elements are presented in Table 4 (Indreptar pentru autorizarea electricienilor, instalații de utilizare până la 1000 V, 1969).

Table 3
The Electric Motor Afferent to the Threshing Machine

Three phase motor start Y-Δ	
The input voltage	U_L = 400 V c.a.
Short circuit protection	I_{sc} = 63 A
Connexion conductors	Aluminium: 25 mm^2 Copper: 16 mm^2
Thermal protection TSA32/32	I_{rt} = 22.8 A
Contactor AC3; AC4; C1, C2, C3.	C1,C2 = I_{nt} = 50 A C3 = I_{nt} = 32 A
Power cable (1)	Aluminium: 4 × 10mm^2 Copper: 4 × 6 mm^2
Power cable (2)	Aluminium: 3 × 10mm^2 Copper: 3 x 6 mm^2
Motor features: power, power factor cos(φ), yield η.	P = 22 kW, cos(φ) = 0,85, η = 0,95
Laying conditions	Floor or bottom of a channel
Ambient temperature	+25ºC

Table 4
The Electric Motor Afferent to the Refrigerent Unit 1

Three phase motor start Y-Δ	
The input voltage	U_L = 400 V c.a.
Short circuit protection	I_{sc} = 125 A
Connexion conductors	Aluminium: 70 mm^2 Copper: 50 mm^2
Thermal protection TSA63/63	I_{rt} = 46,5A
Contactor AC3;AC4; C1, C2, C3.	C1,C2 = I_{nt} = 100 A, C3 = I_{nt} = 63 A
Power cable (1)	Aluminium: 4 × 25mm^2 Copper: 4 × 16mm^2
Power cable (2)	Aluminium: 3 × 25mm^2 Copper: 3 × 16mm^2
Motor features: power, power factor cos(φ), yield η.	P = 45 kW, cos(φ) = 0.85, η = 0.95
Laying conditions	Floor or bottom of a channel
Ambient temperature	+25ºC

The special equipment *REFRIGERATION UNIT 2* is equipped with an electric motor, the calculus elements are presented in Table 5 (Indreptar pentru autorizarea electricienilor, instalații de utilizare până la 1000 V, 1969).

Table 5

The Electric Motor Afferent to the Refrigerent Unit 2

Three phase motor start Y-Δ	
The input voltage	U_L = 400 V c.a.
Short circuit protection	I_{sc} = 50 A
Connexion conductors	Aluminium: 16 mm^2 Copper: 10 mm^2
Thermal protection TSA32/20	I_{rt} = 19.1 A
Contactor AC3;AC4; C1, C2, C3.	C1,C2 = I_{nt} = 40 A, C3 = I_{nt} = 25 A
Power cable (1)	Aluminium: 4 x 6 mm^2 Copper: 4 x 4 mm^2
Power cable (2)	Aluminium: 3 x 6 mm^2 Copper: 3 x 4 mm^2
Motor features: power, power factor cos(φ), yield η.	P = 18.5 kW, cos(φ) = 0.85, η = 0.95
Laying conditions	Floor or bottom of a channel
Ambient temperature	+25ºC

Electric receivers provided with winding in the present case, the three phase motors consume in addition to active electrical power (*Wa*) for mechanical work, and reactive energy (*Wr*) which serves for magnetization. The improvement of the power factor of the electrical installation implicit reducing the reactive energy consumed is obtained in two ways: the natural way (rationalizing the mounting and the functioning of the electric receivers), and the second way is the artificial way (reactive power compensation installations).

The power calculus for Hall – SPACE FOR TAKING OVER, CONDITIONING AND MARKETING OF THE SEA BUCKTHORN is presented in Table 6.

Table 6

The Power Calculus for Improving the Power Factor

Apparent Power	S	162,352.94 VA	$S = a \times U \times I,\ a = \sqrt{3}$
Active power	P	138,000 W	$P = a \times U \times I \times \cos\varphi$
Reactive power	Q	85,524.72 Var	$Q = \sqrt{S^2 - P^2}$
Line voltage	U	400 V	
Power factor	cosφ	0.85	
Line current	I	234.61 A	
Circuit type		Three phase	

So it results: Reactive power = 85.52 kVar for the capacitor bank Varset Fast automat required to be mounted at Hall – SPACE FOR TAKING OVER, CONDITIONING AND MARKETING OF THE SEA BUCKTHORN.

The installation steps of the equipment which performs the automatic compensation control:

- first it is necessary to perform a measurement of the consumed reactive energy;
- the installed power is not sufficient!!!
- also after making the measurements, it is laid down the number of compensation steps;
- the power of the compensation steps is established;
- the estimated power of the compensation panel reactive energy, can be determined from the electricity bill, only if it is a production line and the work schedule is known;
- the capacitor bank *Varset Fast automat* is mounted to distribution boards of the electrical panel.

Another important element in the electrical installation is the *Grounding dispersion resistance*, for which the next is needed: geotechnical study with soil type identification and its resistivity, determining the number of vertical electrodes and the length of the horizontal electrode, their section.

In the electrical installation of the agro-industrial unit the following elements were calculated for the earthing installation:

Galvanized pipe electrodes mounted vertically

Number of electrodes	n = 40
Electrode length	L = 1.5 m
Electrode diameter	D = =33.50 or 1"

Round or flat link electrodes with horizontal mounting

Number of electrodes	n = 1
Electrode length	L = 163 m
Electrode diameter or width	d or b = 40 mm

The type of soil (electrical resistivity) [clay soil according to the geotechnical study], ρ = 80 Ωm. It results from the calculation that the *Grounding dispersion resistance* is, R = 0.43 Ω according to cap. 5 pt. 5.5.7.11., pag.136, from I 7/2011, *„the grounding resistance can be at most 1 Ω when it is common with the lightning protection building grounding installation”*. So the grounding socket is compatible to be connected to the *lightning protection system*.

From the electrical diagram of the switchboards presented in Fig 2 we mention the following:

- connecting an automated starter generator (with bringing up that the *agro-industrial unit* is positioned in a hilly area with frequent interruptions of electricity during summer);
- protection against atmospheric over-voltages;
- differential switches.

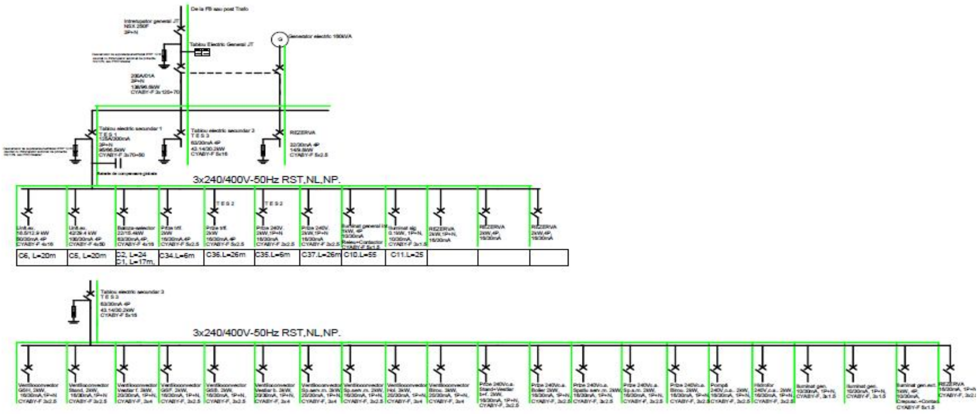

Fig. 2 – General layout of electrical switchboards.

2. Conclusions

The conception, design and execution of an electrical installation related to an agro-industrial unit involves a great deal of work coordinated together with other specialities, respectively: ventilation, and air conditioning, heating and sanitary facilities;

Direct implication of the authorized site supervisor I.S.C. on electrical installations (from the beneficiary) for a good execution of the installation;

This type of agro-industrial unit can create jobs and implicitly high sources of income with an approximate investment 250.000-300.000 euro, amount of money that can be recovered in a period of 3-4 years.

REFERENCES

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INSTALŢIA ELECTRICĂ AFERENTĂ UNITĂŢILOR AGROINDUSTRIALE-CĂTINĂ

(Rezumat)

La o primă vedere instalaţiile electrice aferente unităţilor agroindustriale sunt simple de conceput, proiectat sau executat dar, după o atentă analiză constatăm că sunt necesare multiple cunoştinţe din domeniul tehnic al instalaţiilor electrice pentru construcţii, cu ample şi complexe calcule.