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Loss Analysis Due to Influence of Harmonics in a Distribution System

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1. Introduction

This paper investigates the behavior of losses when non linear loads and consequently harmonics are presente in a distribution system. The analysis were performed for three cases: cold, mild and hot days.

2. System Characterization

The system used as the object of study was the IEEE's LVTestCaseNorthAmerican model, because these are more common and accessible then the Brazilians. It was modified in order to contain the voltages of the Brazilian electrical system. In addition, other modifications and inclusions were made, as shown in sequence.

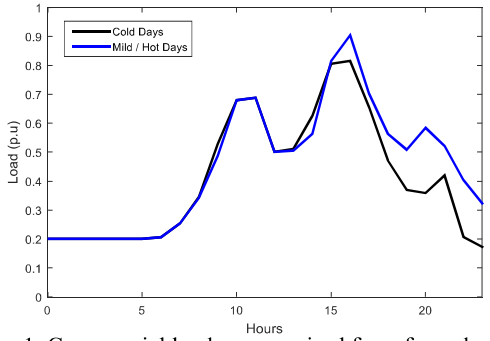

Fig. 1. Commercial load curves raised from fuzzy logic.

The system used has 624 loads, and the load shapes, obtained from fuzzy logic, and spectrum were distributed, in order, as shown in Table II. In Table III, the information of each harmonic spectrum used is shown. In addition, three photovoltaic systems were inserted, totaling 7 kVA.

Table I. – Distribution of Loads Parameters

Quantity	Load shape	Spectrum
74	Commercial	Commercial
75	Residential	Average residential
60	Commercial	-
90	Commercial	Commercial
80	Residential	Computer
125	Residential	Low residential
15	Residential	-
15	Residential	Stereo System
90	Public	Lamp

Table II. – Harmonic Spectrum

Order	3	5	7	9	11	13	15	17	19
Average Residential									
%Mag	46,4	32	17,9	7,07	2,3	6,4	5,1	1,33	2,0
Angle	-162	16,5	21,9	22,7	87,3	121,3	119	117	76,9
Low Residential									
%Mag	30,2	21,3	16,4	10,6	3,0	6,6	4,8	0,46	2,4
Angle	-169	16	-159	22,7	106	-122	58,4	-124	-103
Commercial									
%Mag	16,8	7,5	2,2	1,4	0,5	1,07	0,8	0,6	1,1
Angle	-156	9,5	-161	-5,3	32,3	-140	30,2	7,39	-160
Computer									
%Mag	27	11	5	2	1,7	1,3	1	-	-
Angle	-	-	-	-	-	-	-	-	-
TV									
%Mag	82,3	54,8	25,2	3,4	10,5	11,8	6,3	0,84	0,38
Angle	175	-7,6	173	43,1	-33	146	-42	-1,1	61,7
Stereo System									
%Mag	37,4	17,3	6,0	5,9	2,0	2,6	1,0	1,2	0,7
Angle	-179	-48	-18	133	-128	-46,5	76,6	137	-109
Lamp									
%Mag	66,0	42,4	40,1	28,3	19,6	15,3	10,9	10,2	10,7
Angle	-71	-144	135	47,0	-21,4	-91,6	-149	150	86,9
Inverter									
%Mag	1,16	1,41	0,22	0,04	0,16	0,23	0,11	-	-
Angle	-	-	-	-	-	-	-	-	-

3. Losses Analysis

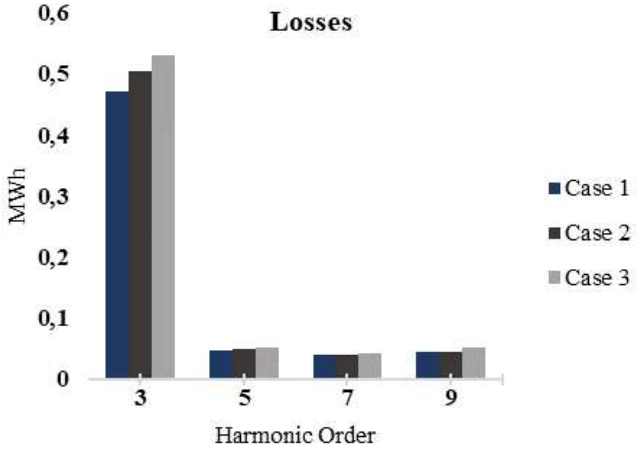

Fig. 2. Losses due to harmonics of order 3 to 9 (MWh)

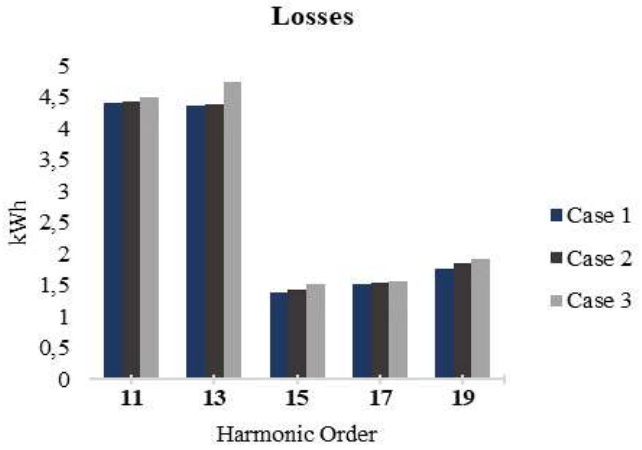

Fig. 3. Losses due to harmonics of order 11 to 19 (kWh)

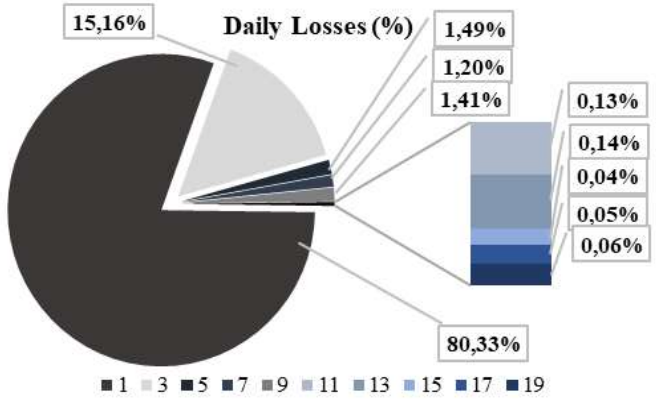

Fig. 4. Mean of daily losses displayed in percentage.

4. Conclusion

It was observed that the losses obtained in the third case were higher, as expected, since the load shapes used predicted this behavior for hot days. From the figures, the third order harmonics are the ones that represent greater losses within this group. The losses of very high order are irrelevant. Also, the losses due to harmonics correspond to about 19.6% of the total.