Notes on Intuitionistic Fuzzy Sets
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Evaluating the performance of catalyst and feedstocks in the fluid catalytic cracking process: Application of InterCriteria Analysis with weight coefficients of the criteria

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Abstract: In this paper, we will apply InterCriteria Analysis to evaluate the performance of two catalysts and two feedstocks in the fluid catalytic cracking process. For the purposes of this analysis, each object is given a weight coefficient which affects the final evaluation between every pair of criteria. After presenting our results, we discuss their implications.

Keywords: InterCriteria analysis, Index matrix, Intuitionistic fuzzy pairs, Fluid catalytic cracking.
2020 Mathematics Subject Classification: 03E72.

1 Introduction

The fluid catalytic cracking (FCC) is a major process in petroleum refining that converts low value heavy oils into high value transportation fuels, and olefins (feeds for the petrochemistry) [1]. Although it celebrated its 80th anniversary the versatility of FCC process has made it a priceless part of each modern refinery [2–5]. Before implementation of a new catalyst or a new feed a preliminary laboratory experiments are typically carried out [6,7]. The laboratory cracking experiments are typically performed at different catalyst-to-oil ratios and interpolated yields at constant conversion, and constant coke are compared to select the best strategy to follow in the commercial FCC unit [8,9]. After the successful application of intercriteria analysis (ICrA) to evaluate petroleum processing data [10–13] we decided to employ the ICrA approach with weight coefficients of the criteria to the FCC data from four cases. They are summarized as follows: MAT (Micro-activity test) FCC experiments with vacuum gas oil activated by addition of 2% FCC slurry oil (SLO) and not activated on two different catalysts were performed. The MAT tests were carried out at reaction temperature of 527°C, catalyst time on stream of 30 seconds and variation of catalyst-to-oil ratio between 1 and 6 wt./wt. The FCC performance for the two catalysts with the two feeds activated, and not activated (total four cases) was compared at constant conversion of 65 wt.%, and at constant yield of coke of 1.9 wt.% obtained by interpolation of the selectivity curves as described in [8,9].

The aim of this study is to evaluate the relations between the different yields, gasoline octane, and gasoline hydrocarbon composition at constant conversion of 65%, and at constant coke of 1.9 wt.% for the two different catalysts that have cracked a straight run vacuum gas oil derived from Urals crude oil and a blend of it with FCC slurry oil in a laboratory MAT unit operating under requirements of the standards ASTM D 3907, and ASTM D 5154.

InterCriteria Analysis (ICA or ICrA) is a method for calculating the dependencies between a pair of criteria, giving its results as Intuitionistic Fuzzy Pairs (IFPs, $\langle\mu, \nu\rangle$, where $\mu + \nu \leq 1$) [14]. When given an input Index Matrix [15] of evaluations of a set of objects by a set of criteria, we perform ICA on a selected pair of criteria by noting the relation between every two object evaluations for each of the two criteria: if the relation is "$>$" or "$<$" for both criteria, we increase the degree of membership (μ); if the relation is "$>$" for one criterion and "$<$" for the other (or vice versa), we increase the degree of non-membership (ν); and if either relation is "$=$", we increase neither. The difference between 1 and the degrees of membership and non-membership gives the degree of uncertainty (π). A higher degree of membership means the second criterion's evaluations tend to increase/decrease when those of the first one increase/decrease (which is known as *positive consonance*), while a higher degree of non-membership implies that the criteria's evaluations tend to increase/decrease in opposite ways (known as *negative consonance*). A high degree of uncertainty means that no definitive correlation can be established between the two criteria (*dissonance*) [16].

When the results of ICA have been calculated between each pair of criteria, we can use the following scale to rank the criteria pairs by the strength of their correlation. The scale is applied forward to membership and in reverse to non-membership values.

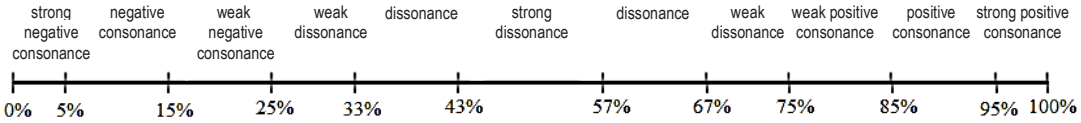

Figure 1. Scale for determination of the type of the correlations between the criteria

For the present investigation, we will add weights to the objects in our dataset, which will be taken into account when calculating the degrees of membership and non-membership between the criteria, as has been described in [20].

2 Results and discussions

2.1 Input data – Constant conv. (65)

Table 1 shows the yield structure, hydrocarbon composition of the obtained gasoline (cracked naphtha = CN), research, and motor octane numbers (RON, and MON respectively), and MON, and RON octane barrels. Two catalysts Futura 70, and equilibrium catalyst sampled from the "LUKOIL Neftohim Burgas" FCC unit designated as E-CAT and two feeds: a straight run vacuum gas oil derived from Urals crude oil, and its blend with 2% FCC SLO were cracked in the MAT FCC unit. The four cases designation is following:

1. FUTURA 70+ = Catalyst Futura 70 (fresh, metal free deactivated) that cracks feed 1 (straight run vacuum gas oil derived from Urals crude oil)
2. FUTURA 70 + 2% SLO = Catalyst Futura 70 (fresh, metal free deactivated) that cracks feed 2 (straight run vacuum gas oil derived from Urals crude oil (98%) mixed with 2% FCC SLO)
3. ECAT = Equilibrium catalyst sampled from "LUKOIL Neftohim Burgas" FCC unit that cracks feed 1 (straight run vacuum gas oil derived from Urals crude oil)
4. E-CAT NEF + 2% SLO = Equilibrium catalyst sampled from "LUKOIL Neftohim Burgas" FCC unit that cracks feed 2 (straight run vacuum gas oil derived from Urals crude oil (98%) mixed with 2% FCC SLO)

Table 1. FCC Yields, hydrocarbon composition, and RON, and MON of cracked naphtha (CN) interpolatated at constant conversion of 65 wt.%.

		Objects	FUTURA 70 + 2% SLO	FUTURA 70+	E-CAT NEF + 2% SLO	ECAT
			P42.157.2	P42.157.1	96301122	96301121
Nr	**Criteria**	**Weight (Objects) ▸ / Weight (Criteria) ▾**	2	1	4	3
1	Conversion at CTO =4	2	63	64	61	63
2	CTO	2	4.2	4.2	4.6	4.2
3	Hydrogen	2	0.074	0.075	0.145	0.138
4	Hydrogen/CTO	2	0.018	0.018	0.032	0.033
5	Carbon	3	2.4	2.4	3	3.3
6	Δ coke	4	0.56	0.58	0.65	0.78
7	Dry gas	2	2.3	2.3	2.3	2.4
8	C3=	4	3.9	3.9	4.1	4
9	C3	1	0.82	0.8	0.93	0.83
10	Total C3	1	4.7	4.7	5	4.8
11	i-C4=	5	1.1	1.1	1.2	1.2
12	i-C4	5	2.9	2.8	3.1	2.8
13	n-C4	1	0.67	0.66	0.72	0.65
14	Total C4='s	5	4.8	4.8	4.8	4.7
15	Total C4	3	8.3	8.2	8.6	8.2
16	C3= + C4=	5	8.7	8.7	8.9	8.7
17	LPG	2	13.0	12.9	13.7	13
18	LPG Olef.	2	66.7	67.0	65.4	67.1
19	CN	6	47.3	47.2	45.9	46.2
20	LC0 (221-3338°C)	6	17.9	17.9	17.8	22.1
21	HCO (338°C+)	1	17.1	17.1	17.2	12.9
22	CN n-Paraffins	1	4.3	4.4	4.1	4.0
23	CN i-Paraffins	5	36.1	36.1	34.7	34.3
24	CN Aromatics	4	31.1	30.7	31.3	31.2
25	CN Naphthenes	4	10.1	10.3	10.3	10.3
26	CN Olefins	4	18.3	18.6	19.7	20.2
27	GC-MON	7	79.8	79.8	80.3	80.2
28	GC-RON	7	89.1	89.0	89.9	89.9
29	MON octane barrels	7	37.7	37.7	36.8	37.1
30	RON octane barrels	7	42.1	42.1	41.3	41.6

This investigation will only use the object weights to calculate the correlation IFPs for each criteria pair.

After performing ICA with the object weights, we get the results shown in Table 2. In total, the table compares 435 intercriteria pairs evaluating 4 objects.

Table 2. Intuitionistic fuzzy pairs after applying ICA on the data for Constant conv. (65)

	1	2	3	4	5	6	7	8	9	10
1.Conversion at CTO =4		⟨0,0.69⟩	⟨0.06,0.77⟩	⟨0.34,0.43⟩	⟨0.34,0.43⟩	⟨0.4,0.43⟩	⟨0.34,0.09⟩	⟨0,0.77⟩	⟨0,0.83⟩	⟨0,0.77⟩
2.CTO	⟨0,0.69⟩		⟨0.69,0⟩	⟨0.34,0.34⟩	⟨0.34,0.34⟩	⟨0.34,0.34⟩	⟨0,0.34⟩	⟨0.69,0⟩	⟨0.69,0⟩	⟨0.69,0⟩
3.Hydrogen	⟨0.06,0.77⟩	⟨0.69,0⟩		⟨0.6,0.34⟩	⟨0.6,0.34⟩	⟨0.66,0.34⟩	⟨0.26,0.34⟩	⟨0.94,0⟩	⟨0.94,0.06⟩	⟨0.94,0⟩
4.Hydrogen/CTO	⟨0.34,0.43⟩	⟨0.34,0.34⟩	⟨0.6,0.34⟩		⟨0.94,0⟩	⟨0.94,0⟩	⟨0.6,0⟩	⟨0.6,0.34⟩	⟨0.6,0.34⟩	⟨0.6,0.34⟩
5.Carbon	⟨0.34,0.43⟩	⟨0.34,0.34⟩	⟨0.6,0.34⟩	⟨0.94,0⟩		⟨0.94,0⟩	⟨0.6,0⟩	⟨0.6,0.34⟩	⟨0.6,0.34⟩	⟨0.6,0.34⟩
6.Δ coke	⟨0.4,0.43⟩	⟨0.34,0.34⟩	⟨0.66,0.34⟩	⟨0.94,0⟩	⟨0.94,0⟩		⟨0.6,0⟩	⟨0.6,0.34⟩	⟨0.6,0.4⟩	⟨0.6,0.34⟩
7.Dry gas	⟨0.34,0.09⟩	⟨0,0.34⟩	⟨0.26,0.34⟩	⟨0.6,0⟩	⟨0.6,0⟩	⟨0.6,0⟩		⟨0.26,0.34⟩	⟨0.26,0.34⟩	⟨0.26,0.34⟩
8.C3=	⟨0,0.77⟩	⟨0.69,0⟩	⟨0.94,0⟩	⟨0.6,0.34⟩	⟨0.6,0.34⟩	⟨0.6,0.34⟩	⟨0.26,0.34⟩		⟨0.94,0⟩	⟨0.94,0⟩
9.C3	0,0.83⟩	⟨0.69,0⟩	⟨0.94,0.06⟩	⟨0.6,0.34⟩	⟨0.6,0.34⟩	⟨0.6,0.4⟩	⟨0.26,0.34⟩	⟨0.94,0⟩		⟨0.94,0⟩
10.Total C3	⟨0,0.77⟩	⟨0.69,0⟩	⟨0.94,0⟩	⟨0.6,0.34⟩	⟨0.6,0.34⟩	⟨0.6,0.34⟩	⟨0.26,0.34⟩	⟨0.94,0⟩	⟨0.94,0⟩	
11.i-C4=	⟨0,0.43⟩	⟨0.34,0⟩	⟨0.6,0⟩	⟨0.6,0⟩	⟨0.6,0⟩	⟨0.6,0⟩	⟨0.26,0⟩	⟨0.6,0⟩	⟨0.6,0⟩	⟨0.6,0⟩
12.i-C4	⟨0,0.74⟩	⟨0.69,0⟩	⟨0.69,0.23⟩	⟨0.34,0.51⟩	⟨0.34,0.51⟩	⟨0.34,0.57⟩	⟨0,0.51⟩	⟨0.69,0.17⟩	⟨0.74,0.17⟩	⟨0.69,0.17⟩
13.n-C4	⟨0.09,0.74⟩	⟨0.69,0⟩	⟨0.69,0.31⟩	⟨0.34,0.6⟩	⟨0.34,0.6⟩	⟨0.34,0.66⟩	⟨0,0.6⟩	⟨0.69,0.26⟩	⟨0.74,0.26⟩	⟨0.69,0.26⟩
14.Total C4='s	⟨0.09,0.34⟩	⟨0.34,0⟩	⟨0.34,0.26⟩	⟨0,0.6⟩	⟨0,0.6⟩	⟨0,0.6⟩	⟨0,0.6⟩	⟨0.34,0.26⟩	⟨0.34,0.26⟩	⟨0.34,0.26⟩
15.Total C4	⟨0,0.74⟩	⟨0.69,0⟩	⟨0.69,0.23⟩	⟨0.34,0.51⟩	⟨0.34,0.51⟩	⟨0.34,0.57⟩	⟨0,0.51⟩	⟨0.69,0.17⟩	⟨0.74,0.17⟩	⟨0.69,0.17⟩
16.C3= + C4=	⟨0,0.69⟩	⟨0.69,0⟩	⟨0.69,0⟩	⟨0.34,0.34⟩	⟨0.34,0.34⟩	⟨0.34,0.34⟩	⟨0,0.34⟩	⟨0.69,0⟩	⟨0.69,0⟩	⟨0.69,0⟩
17.LPG	⟨0,0.83⟩	⟨0.69,0⟩	⟨0.77,0.06⟩	⟨0.43,0.34⟩	⟨0.43,0.34⟩	⟨0.43,0.4⟩	⟨0.09,0.34⟩	⟨0.77,0⟩	⟨0.83,0⟩	⟨0.77,0⟩
18.LPG Olef.	⟨0.74,0.09⟩	⟨0,0.69⟩	⟨0.31,0.69⟩	⟨0.6,0.34⟩	⟨0.6,0.34⟩	⟨0.66,0.34⟩	⟨0.6,0⟩	⟨0.26,0.69⟩	⟨0.26,0.74⟩	⟨0.26,0.69⟩
19.CN	⟨0.77,0.06⟩	⟨0,0.69⟩	⟨0,1⟩	⟨0.34,0.6⟩	⟨0.34,0.6⟩	⟨0.34,0.66⟩	⟨0.34,0.26⟩	⟨0,0.94⟩	⟨0.06,0.94⟩	⟨0,0.94⟩
20.LC0 (221-3338°C)	⟨0.69,0.09⟩	⟨0,0.69⟩	⟨0.26,0.69⟩	⟨0.6,0.34⟩	⟨0.6,0.34⟩	⟨0.6,0.34⟩	⟨0.6,0⟩	⟨0.26,0.69⟩	⟨0.26,0.69⟩	⟨0.26,0.69⟩
21.HCO (338°C+)	⟨0.09,0.69⟩	⟨0.69,0⟩	⟨0.69,0.26⟩	⟨0.34,0.6⟩	⟨0.34,0.6⟩	⟨0.34,0.6⟩	⟨0,0.6⟩	⟨0.69,0.26⟩	⟨0.69,0.26⟩	⟨0.69,0.26⟩
22.CN n-Paraffins	⟨0.49,0.34⟩	⟨0.34,0.34⟩	⟨0.4,0.6⟩	⟨0,0.94⟩	⟨0,0.94⟩	⟨0.06,0.94⟩	⟨0,0.6⟩	⟨0.34,0.6⟩	⟨0.34,0.66⟩	⟨0.34,0.6⟩
23.CN i-Paraffins	⟨0.43,0.34⟩	⟨0.34,0.34⟩	⟨0.34,0.6⟩	⟨0,0.94⟩	⟨0,0.94⟩	⟨0,0.94⟩	⟨0,0.6⟩	⟨0.34,0.6⟩	⟨0.34,0.6⟩	⟨0.34,0.6⟩
24.CN Aromatics	⟨0,0.83⟩	⟨0.69,0⟩	⟨0.94,0.06⟩	⟨0.6,0.34⟩	⟨0.6,0.34⟩	⟨0.6,0.4⟩	⟨0.26,0.34⟩	⟨0.94,0⟩	⟨1,0⟩	⟨0.94,0⟩
25.CN Naphthenes	⟨0.06,0.23⟩	⟨0.23,0⟩	⟨0.46,0⟩	⟨0.4,0⟩	⟨0.4,0⟩	⟨0.46,0⟩	⟨0.17,0⟩	⟨0.4,0⟩	⟨0.4,0.06⟩	⟨0.4,0⟩
26.CN Olefins	⟨0.4,0.43⟩	⟨0.34,0.34⟩	⟨0.66,0.34⟩	⟨0.94,0⟩	⟨0.94,0⟩	⟨1,0⟩	⟨0.6,0⟩	⟨0.6,0.34⟩	⟨0.6,0.4⟩	⟨0.6,0.34⟩
27.GC-MON	⟨0,0.77⟩	⟨0.69,0⟩	⟨0.94,0⟩	⟨0.6,0.34⟩	⟨0.6,0.34⟩	⟨0.6,0.34⟩	⟨0.26,0.34⟩	⟨0.94,0⟩	⟨0.94,0⟩	⟨0.94,0⟩
28.GC-RON	⟨0,0.49⟩	⟨0.34,0⟩	⟨0.6,0.06⟩	⟨0.6,0⟩	⟨0.6,0⟩	⟨0.6,0.06⟩	⟨0.26,0⟩	⟨0.6,0⟩	⟨0.66,0⟩	⟨0.6,0⟩
29.MON octane barrels	⟨0.77,0⟩	⟨0,0.69⟩	⟨0,0.94⟩	⟨0.34,0.6⟩	⟨0.34,0.6⟩	⟨0.34,0.6⟩	⟨0.34,0.26⟩	⟨0,0.94⟩	⟨0,0.94⟩	⟨0,0.94⟩
30.RON octane barrels	⟨0.77,0⟩	⟨0,0.69⟩	⟨0,0.94⟩	⟨0.34,0.6⟩	⟨0.34,0.6⟩	⟨0.34,0.6⟩	⟨0.34,0.26⟩	⟨0,0.94⟩	⟨0,0.94⟩	⟨0,0.94⟩

Contd. columns 11-20

	11	12	13	14	15	16	17	18	19	20
1.Conversion at CTO =4	⟨0,0.43⟩	⟨0,0.74⟩	⟨0.09,0.74⟩	⟨0.09,0.34⟩	⟨0,0.74⟩	⟨0,0.69⟩	⟨0,0.83⟩	⟨0.74,0.09⟩	⟨0.77,0.06⟩	⟨0.69,0.09⟩
2.CTO	⟨0.34,0⟩	⟨0.69,0⟩	⟨0.69,0⟩	⟨0.34,0⟩	⟨0.69,0⟩	⟨0.69,0⟩	⟨0.69,0⟩	⟨0,0.69⟩	⟨0,0.69⟩	⟨0,0.69⟩
3.Hydrogen	⟨0.6,0⟩	⟨0.69,0.23⟩	⟨0.69,0.31⟩	⟨0.34,0.26⟩	⟨0.69,0.23⟩	⟨0.69,0⟩	⟨0.77,0.06⟩	⟨0.31,0.69⟩	⟨0,1⟩	⟨0.26,0.69⟩
4.Hydrogen/CTO	⟨0.6,0⟩	⟨0.34,0.51⟩	⟨0.34,0.6⟩	⟨0,0.6⟩	⟨0.34,0.51⟩	⟨0.34,0.34⟩	⟨0.43,0.34⟩	⟨0.6,0.34⟩	⟨0.34,0.6⟩	⟨0.6,0.34⟩
5.Carbon	⟨0.6,0⟩	⟨0.34,0.51⟩	⟨0.34,0.6⟩	⟨0,0.6⟩	⟨0.34,0.51⟩	⟨0.34,0.34⟩	⟨0.43,0.34⟩	⟨0.6,0.34⟩	⟨0.34,0.6⟩	⟨0.6,0.34⟩
6.Δ coke	⟨0.6,0⟩	⟨0.34,0.57⟩	⟨0.34,0.66⟩	⟨0,0.6⟩	⟨0.34,0.57⟩	⟨0.34,0.34⟩	⟨0.43,0.4⟩	⟨0.66,0.34⟩	⟨0.34,0.66⟩	⟨0.6,0.34⟩

	11	12	13	14	15	16	17	18	19	20
7.Dry gas	⟨0.26,0⟩	⟨0,0.51⟩	⟨0,0.6⟩	⟨0,0.6⟩	⟨0,0.51⟩	⟨0,0.34⟩	⟨0.09,0.34⟩	⟨0.6,0⟩	⟨0.34,0.26⟩	⟨0.6,0⟩
8.C3=	⟨0.6,0⟩	⟨0.69,0.17⟩	⟨0.69,0.26⟩	⟨0.34,0.26⟩	⟨0.69,0.17⟩	⟨0.69,0⟩	⟨0.77,0⟩	⟨0.26,0.69⟩	⟨0,0.94⟩	⟨0.26,0.69⟩
9.C3	⟨0.6,0⟩	⟨0.74,0.17⟩	⟨0.74,0.26⟩	⟨0.34,0.26⟩	⟨0.74,0.17⟩	⟨0.69,0⟩	⟨0.83,0⟩	⟨0.26,0.74⟩	⟨0.06,0.94⟩	⟨0.26,0.69⟩
10.Total C3	⟨0.6,0⟩	⟨0.69,0.17⟩	⟨0.69,0.26⟩	⟨0.34,0.26⟩	⟨0.69,0.17⟩	⟨0.69,0⟩	⟨0.77,0⟩	⟨0.26,0.69⟩	⟨0,0.94⟩	⟨0.26,0.69⟩
11.i-C4=		⟨0.34,0.17⟩	⟨0.34,0.26⟩	⟨0,0.26⟩	⟨0.34,0.17⟩	⟨0.34,0⟩	⟨0.43,0⟩	⟨0.26,0.34⟩	⟨0,0.6⟩	⟨0.26,0.34⟩
12.i-C4	⟨0.34,0.17⟩		⟨0.91,0⟩	⟨0.51,0⟩	⟨0.91,0⟩	⟨0.69,0⟩	⟨0.74,0⟩	⟨0,0.91⟩	⟨0.23,0.69⟩	⟨0,0.86⟩
13.n-C4	⟨0.34,0.26⟩	⟨0.91,0⟩		⟨0.6,0⟩	⟨0.91,0⟩	⟨0.69,0⟩	⟨0.74,0.09⟩	⟨0,1⟩	⟨0.31,0.69⟩	⟨0,0.94⟩
14.Total C4='s	⟨0,0.26⟩	⟨0.51,0⟩	⟨0.6,0⟩		⟨0.51,0⟩	⟨0.34,0⟩	⟨0.34,0.09⟩	⟨0,0.6⟩	⟨0.26,0.34⟩	⟨0,0.6⟩
15.Total C4	⟨0.34,0.17⟩	⟨0.91,0⟩	⟨0.91,0⟩	⟨0.51,0⟩		⟨0.69,0⟩	⟨0.74,0⟩	⟨0,0.91⟩	⟨0.23,0.69⟩	⟨0,0.86⟩
16.C3= + C4=	⟨0.34,0⟩	⟨0.69,0⟩	⟨0.69,0⟩	⟨0.34,0⟩	⟨0.69,0⟩		⟨0.69,0⟩	⟨0,0.69⟩	⟨0,0.69⟩	⟨0,0.69⟩
17.LPG	⟨0.43,0⟩	⟨0.74,0⟩	⟨0.74,0.09⟩	⟨0.34,0.09⟩	⟨0.74,0⟩	⟨0.69,0⟩		⟨0.09,0.74⟩	⟨0.06,0.77⟩	⟨0.09,0.69⟩
18.LPG Olef.	⟨0.26,0.34⟩	⟨0,0.91⟩	⟨0,1⟩	⟨0,0.6⟩	⟨0,0.91⟩	⟨0,0.69⟩	⟨0.09,0.74⟩		⟨0.69,0.31⟩	⟨0.94,0⟩
19.CN	⟨0,0.6⟩	⟨0.23,0.69⟩	⟨0.31,0.69⟩	⟨0.26,0.34⟩	⟨0.23,0.69⟩	⟨0,0.69⟩	⟨0.06,0.77⟩	⟨0.69,0.31⟩		⟨0.69,0.26⟩
20.LC0 (221-3338°C)	⟨0.26,0.34⟩	⟨0,0.86⟩	⟨0,0.94⟩	⟨0,0.6⟩	⟨0,0.86⟩	⟨0,0.69⟩	⟨0.09,0.69⟩	⟨0.94,0⟩	⟨0.69,0.26⟩	
21.HCO (338°C+)	⟨0.34,0.26⟩	⟨0.86,0⟩	⟨0.94,0⟩	⟨0.6,0⟩	⟨0.86,0⟩	⟨0.69,0⟩	⟨0.69,0.09⟩	⟨0,0.94⟩	⟨0.26,0.69⟩	⟨0,0.94⟩
22.CN n-Paraffins	⟨0,0.6⟩	⟨0.51,0.4⟩	⟨0.6,0.4⟩	⟨0.6,0⟩	⟨0.51,0.4⟩	⟨0.34,0.34⟩	⟨0.34,0.49⟩	⟨0.4,0.6⟩	⟨0.6,0.4⟩	⟨0.34,0.6⟩
23.CN i-Paraffins	⟨0,0.6⟩	⟨0.51,0.34⟩	⟨0.6,0.34⟩	⟨0.6,0⟩	⟨0.51,0.34⟩	⟨0.34,0.34⟩	⟨0.34,0.43⟩	⟨0.34,0.6⟩	⟨0.6,0.34⟩	⟨0.34,0.6⟩
24.CN Aromatics	⟨0.6,0⟩	⟨0.74,0.17⟩	⟨0.74,0.26⟩	⟨0.34,0.26⟩	⟨0.74,0.17⟩	⟨0.69,0⟩	⟨0.83,0⟩	⟨0.26,0.74⟩	⟨0.06,0.94⟩	⟨0.26,0.69⟩
25.CN Naphthenes	⟨0.4,0⟩	⟨0.23,0.23⟩	⟨0.23,0.23⟩	⟨0,0.17⟩	⟨0.23,0.23⟩	⟨0.23,0⟩	⟨0.23,0.06⟩	⟨0.23,0.23⟩	⟨0,0.46⟩	⟨0.17,0.23⟩
26.CN Olefins	⟨0.6,0⟩	⟨0.34,0.57⟩	⟨0.34,0.66⟩	⟨0,0.6⟩	⟨0.34,0.57⟩	⟨0.34,0.34⟩	⟨0.43,0.4⟩	⟨0.66,0.34⟩	⟨0.34,0.66⟩	⟨0.6,0.34⟩
27.GC-MON	⟨0.6,0⟩	⟨0.69,0.17⟩	⟨0.69,0.26⟩	⟨0.34,0.26⟩	⟨0.69,0.17⟩	⟨0.69,0⟩	⟨0.77,0⟩	⟨0.26,0.69⟩	⟨0,0.94⟩	⟨0.26,0.69⟩
28.GC-RON	⟨0.6,0⟩	⟨0.4,0.17⟩	⟨0.4,0.26⟩	⟨0,0.26⟩	⟨0.4,0.17⟩	⟨0.34,0⟩	⟨0.49,0⟩	⟨0.26,0.4⟩	⟨0.06,0.6⟩	⟨0.26,0.34⟩
29.MON octane barrels	⟨0,0.6⟩	⟨0.17,0.69⟩	⟨0.26,0.69⟩	⟨0.26,0.34⟩	⟨0.17,0.69⟩	⟨0,0.69⟩	⟨0,0.77⟩	⟨0.69,0.26⟩	⟨0.94,0⟩	⟨0.69,0.26⟩
30.RON octane barrels	⟨0,0.6⟩	⟨0.17,0.69⟩	⟨0.26,0.69⟩	⟨0.26,0.34⟩	⟨0.17,0.69⟩	⟨0,0.69⟩	⟨0,0.77⟩	⟨0.69,0.26⟩	⟨0.94,0⟩	⟨0.69,0.26⟩

Contd. columns 21-30

	21	22	23	24	25	26	27	28	29	30
1.Conversion at CTO =4	⟨0.09,0.69⟩	⟨0.49,0.34⟩	⟨0.43,0.34⟩	⟨0,0.83⟩	⟨0.06,0.23⟩	⟨0.4,0.43⟩	⟨0,0.77⟩	⟨0,0.49⟩	⟨0.77,0⟩	⟨0.77,0⟩
2.CTO	⟨0.69,0⟩	⟨0.34,0.34⟩	⟨0.34,0.34⟩	⟨0.69,0⟩	⟨0.23,0⟩	⟨0.34,0.34⟩	⟨0.69,0⟩	⟨0.34,0⟩	⟨0,0.69⟩	⟨0,0.69⟩
3.Hydrogen	⟨0.69,0.26⟩	⟨0.4,0.6⟩	⟨0.34,0.6⟩	⟨0.94,0.06⟩	⟨0.46,0⟩	⟨0.66,0.34⟩	⟨0.94,0⟩	⟨0.6,0.06⟩	⟨0,0.94⟩	⟨0,0.94⟩
4.Hydrogen/CTO	⟨0.34,0.6⟩	⟨0,0.94⟩	⟨0,0.94⟩	⟨0.6,0.34⟩	⟨0.4,0⟩	⟨0.94,0⟩	⟨0.6,0.34⟩	⟨0.6,0⟩	⟨0.34,0.6⟩	⟨0.34,0.6⟩
5.Carbon	⟨0.34,0.6⟩	⟨0,0.94⟩	⟨0,0.94⟩	⟨0.6,0.34⟩	⟨0.4,0⟩	⟨0.94,0⟩	⟨0.6,0.34⟩	⟨0.6,0⟩	⟨0.34,0.6⟩	⟨0.34,0.6⟩
6.Δ coke	⟨0.34,0.6⟩	⟨0.06,0.94⟩	⟨0,0.94⟩	⟨0.6,0.4⟩	⟨0.46,0⟩	⟨1,0⟩	⟨0.6,0.34⟩	⟨0.6,0.06⟩	⟨0.34,0.6⟩	⟨0.34,0.6⟩
7.Dry gas	⟨0,0.6⟩	⟨0,0.6⟩	⟨0,0.6⟩	⟨0.26,0.34⟩	⟨0.17,0⟩	⟨0.6,0⟩	⟨0.26,0.34⟩	⟨0.26,0⟩	⟨0.34,0.26⟩	⟨0.34,0.26⟩
8.C3=	⟨0.69,0.26⟩	⟨0.34,0.6⟩	⟨0.34,0.6⟩	⟨0.94,0⟩	⟨0.4,0⟩	⟨0.6,0.34⟩	⟨0.94,0⟩	⟨0.6,0⟩	⟨0,0.94⟩	⟨0,0.94⟩
9.C3	⟨0.69,0.26⟩	⟨0.34,0.66⟩	⟨0.34,0.6⟩	⟨1,0⟩	⟨0.4,0.06⟩	⟨0.6,0.4⟩	⟨0.94,0⟩	⟨0.66,0⟩	⟨0,0.94⟩	⟨0,0.94⟩
10.Total C3	⟨0.69,0.26⟩	⟨0.34,0.6⟩	⟨0.34,0.6⟩	⟨0.94,0⟩	⟨0.4,0⟩	⟨0.6,0.34⟩	⟨0.94,0⟩	⟨0.6,0⟩	⟨0,0.94⟩	⟨0,0.94⟩
11.i-C4=	⟨0.34,0.26⟩	⟨0,0.6⟩	⟨0,0.6⟩	⟨0.6,0⟩	⟨0.4,0⟩	⟨0.6,0⟩	⟨0.6,0⟩	⟨0.6,0⟩	⟨0,0.6⟩	⟨0,0.6⟩
12.i-C4	⟨0.86,0⟩	⟨0.51,0.4⟩	⟨0.51,0.34⟩	⟨0.74,0.17⟩	⟨0.23,0.23⟩	⟨0.34,0.57⟩	⟨0.69,0.17⟩	⟨0.4,0.17⟩	⟨0.17,0.69⟩	⟨0.17,0.69⟩
13.n-C4	⟨0.94,0⟩	⟨0.6,0.4⟩	⟨0.6,0.34⟩	⟨0.74,0.26⟩	⟨0.23,0.23⟩	⟨0.34,0.66⟩	⟨0.69,0.26⟩	⟨0.4,0.26⟩	⟨0.26,0.69⟩	⟨0.26,0.69⟩
14.Total C4='s	⟨0.6,0⟩	⟨0.6,0⟩	⟨0.6,0⟩	⟨0.34,0.26⟩	⟨0,0.17⟩	⟨0,0.6⟩	⟨0.34,0.26⟩	⟨0,0.26⟩	⟨0.26,0.34⟩	⟨0.26,0.34⟩
15.Total C4	⟨0.86,0⟩	⟨0.51,0.4⟩	⟨0.51,0.34⟩	⟨0.74,0.17⟩	⟨0.23,0.23⟩	⟨0.34,0.57⟩	⟨0.69,0.17⟩	⟨0.4,0.17⟩	⟨0.17,0.69⟩	⟨0.17,0.69⟩
16.C3= + C4=	⟨0.69,0⟩	⟨0.34,0.34⟩	⟨0.34,0.34⟩	⟨0.69,0⟩	⟨0.23,0⟩	⟨0.34,0.34⟩	⟨0.69,0⟩	⟨0.34,0⟩	⟨0,0.69⟩	⟨0,0.69⟩
17.LPG	⟨0.69,0.09⟩	⟨0.34,0.49⟩	⟨0.34,0.43⟩	⟨0.83,0⟩	⟨0.23,0.06⟩	⟨0.43,0.4⟩	⟨0.77,0⟩	⟨0.49,0⟩	⟨0,0.77⟩	⟨0,0.77⟩
18.LPG Olef.	⟨0,0.94⟩	⟨0.4,0.6⟩	⟨0.34,0.6⟩	⟨0.26,0.74⟩	⟨0.23,0.23⟩	⟨0.66,0.34⟩	⟨0.26,0.69⟩	⟨0.26,0.4⟩	⟨0.69,0.26⟩	⟨0.69,0.26⟩
19.CN	⟨0.26,0.69⟩	⟨0.6,0.4⟩	⟨0.6,0.34⟩	⟨0.06,0.94⟩	⟨0,0.46⟩	⟨0.34,0.66⟩	⟨0,0.94⟩	⟨0.06,0.6⟩	⟨0.94,0⟩	⟨0.94,0⟩

	21	22	23	24	25	26	27	28	29	30
20.LC0 (221-3338°C)	⟨0,0.94⟩	⟨0.34,0.6⟩	⟨0.34,0.6⟩	⟨0.26,0.69⟩	⟨0.17,0.23⟩	⟨0.6,0.34⟩	⟨0.26,0.69⟩	⟨0.26,0.34⟩	⟨0.69,0.26⟩	⟨0.69,0.26⟩
21.HCO (338°C+)		⟨0.6,0.34⟩	⟨0.6,0.34⟩	⟨0.69,0.26⟩	⟨0.23,0.17⟩	⟨0.34,0.6⟩	⟨0.69,0.26⟩	⟨0.34,0.26⟩	⟨0.26,0.69⟩	⟨0.26,0.69⟩
22.CN n-Paraffins	⟨0.6,0.34⟩		⟨0.94,0⟩	⟨0.34,0.66⟩	⟨0.06,0.4⟩	⟨0.06,0.94⟩	⟨0.34,0.6⟩	⟨0,0.66⟩	⟨0.6,0.34⟩	⟨0.6,0.34⟩
23.CN i-Paraffins	⟨0.6,0.34⟩	⟨0.94,0⟩		⟨0.34,0.6⟩	⟨0,0.4⟩	⟨0,0.94⟩	⟨0.34,0.6⟩	⟨0,0.6⟩	⟨0.6,0.34⟩	⟨0.6,0.34⟩
24.CN Aromatics	⟨0.69,0.26⟩	⟨0.34,0.66⟩	⟨0.34,0.6⟩		⟨0.4,0.06⟩	⟨0.6,0.4⟩	⟨0.94,0⟩	⟨0.66,0⟩	⟨0,0.94⟩	⟨0,0.94⟩
25.CN Naphthenes	⟨0.23,0.17⟩	⟨0.06,0.4⟩	⟨0,0.4⟩	⟨0.4,0.06⟩		⟨0.46,0⟩	⟨0.4,0⟩	⟨0.4,0.06⟩	⟨0,0.4⟩	⟨0,0.4⟩
26.CN Olefins	⟨0.34,0.6⟩	⟨0.06,0.94⟩	⟨0,0.94⟩	⟨0.6,0.4⟩	⟨0.46,0⟩		⟨0.6,0.34⟩	⟨0.6,0.06⟩	⟨0.34,0.6⟩	⟨0.34,0.6⟩
27.GC-MON	⟨0.69,0.26⟩	⟨0.34,0.6⟩	⟨0.34,0.6⟩	⟨0.94,0⟩	⟨0.4,0⟩	⟨0.6,0.34⟩		⟨0.6,0⟩	⟨0,0.94⟩	⟨0,0.94⟩
28.GC-RON	⟨0.34,0.26⟩	⟨0,0.66⟩	⟨0,0.6⟩	⟨0.66,0⟩	⟨0.4,0.06⟩	⟨0.6,0.06⟩	⟨0.6,0⟩		⟨0,0.6⟩	⟨0,0.6⟩
29.MON octane barrels	⟨0.26,0.69⟩	⟨0.6,0.34⟩	⟨0.6,0.34⟩	⟨0,0.94⟩	⟨0,0.4⟩	⟨0.34,0.6⟩	⟨0,0.94⟩	⟨0,0.6⟩		⟨0.94,0⟩
30.RON octane barrels	⟨0.26,0.69⟩	⟨0.6,0.34⟩	⟨0.6,0.34⟩	⟨0,0.94⟩	⟨0,0.4⟩	⟨0.34,0.6⟩	⟨0,0.94⟩	⟨0,0.6⟩	⟨0.94,0⟩	

Table 3 shows the which criteria pairs fall in the different types of consonance and dissonance. The results are constrained by the small number of objects, but we get the following groupings:

- 2 pairs of criteria are in strong positive consonance and 2 in strong negative consonance;
- 30 pairs of criteria are in positive consonance and 32 – in negative consonance;
- 9 pairs are in weak positive consonance and 10 – in weak negative consonance;
- 59 pairs are in weak dissonance on the positive side and 42 – on the negative;
- 75 pairs are in dissonance on the positive side and 59 – on the negative;
- 115 pairs are in strong dissonance.

Table 3. Types of correlations for Constant conv. (65)

Type of correlations	Pairs	Nr. of pairs of criteria
strong positive consonance	Criterion 6 - Criterion 26: ⟨1, 0⟩ Criterion 9 - Criterion 24: ⟨1, 0⟩	**2**
positive consonance	Criterion 3 - Criterion 8: ⟨0.94, 0⟩ Criterion 3 - Criterion 10: ⟨0.94, 0⟩ Criterion 3 - Criterion 27: ⟨0.94, 0⟩ Criterion 4 - Criterion 5: ⟨0.94, 0⟩ Criterion 4 - Criterion 6: ⟨0.94, 0⟩ Criterion 4 - Criterion 26: ⟨0.94, 0⟩ Criterion 5 - Criterion 6: ⟨0.94, 0⟩ Criterion 5 - Criterion 26: ⟨0.94, 0⟩ Criterion 8 - Criterion 9: ⟨0.94, 0⟩ Criterion 8 - Criterion 10: ⟨0.94, 0⟩ Criterion 8 - Criterion 24: ⟨0.94, 0⟩ Criterion 8 - Criterion 27: ⟨0.94, 0⟩ Criterion 9 - Criterion 10: ⟨0.94, 0⟩ Criterion 9 - Criterion 27: ⟨0.94, 0⟩ Criterion 10 - Criterion 24: ⟨0.94, 0⟩ Criterion 10 - Criterion 27: ⟨0.94, 0⟩ Criterion 13 - Criterion 21: ⟨0.94, 0⟩ Criterion 18 - Criterion 20: ⟨0.94, 0⟩ Criterion 19 - Criterion 29: ⟨0.94, 0⟩ Criterion 19 - Criterion 30: ⟨0.94, 0⟩ Criterion 22 - Criterion 23: ⟨0.94, 0⟩ Criterion 24 - Criterion 27: ⟨0.94, 0⟩ Criterion 29 - Criterion 30: ⟨0.94, 0⟩ Criterion 12 - Criterion 13: ⟨0.91, 0⟩ Criterion 12 - Criterion 15: ⟨0.91, 0⟩ Criterion 13 - Criterion 15: ⟨0.91, 0⟩ Criterion 3 - Criterion 9: ⟨0.94, 0.06⟩ Criterion 3 - Criterion 24: ⟨0.94, 0.06⟩	**30**
	Criterion 12 - Criterion 21: ⟨0.86, 0⟩ Criterion 15 - Criterion 21: ⟨0.86, 0⟩	
weak positive consonance	Criterion 9 - Criterion 17: ⟨0.83, 0⟩ Criterion 17 - Criterion 24: ⟨0.83, 0⟩ Criterion 1 - Criterion 29: ⟨0.77, 0⟩ Criterion 1 - Criterion 30: ⟨0.77, 0⟩ Criterion 8 - Criterion 17: ⟨0.77, 0⟩ Criterion 10 - Criterion 17: ⟨0.77, 0⟩ Criterion 17 - Criterion 27: ⟨0.77, 0⟩ Criterion 1 - Criterion 19: ⟨0.77, 0.06⟩ Criterion 3 - Criterion 17: ⟨0.77, 0.06⟩	**9**
weak dissonance	Criterion 12 - Criterion 17: ⟨0.74, 0⟩ Criterion 15 - Criterion 17: ⟨0.74, 0⟩ Criterion 2 - Criterion 3: ⟨0.69, 0⟩ Criterion 2 - Criterion 8: ⟨0.69, 0⟩ Criterion 2 - Criterion 9: ⟨0.69, 0⟩ Criterion 2 - Criterion 10: ⟨0.69, 0⟩ Criterion 2 - Criterion 12: ⟨0.69, 0⟩ Criterion 2 - Criterion 13: ⟨0.69, 0⟩ Criterion 2 - Criterion 15: ⟨0.69, 0⟩ Criterion 2 - Criterion 16: ⟨0.69, 0⟩ Criterion 2 - Criterion 17: ⟨0.69, 0⟩ Criterion 2 - Criterion 21: ⟨0.69, 0⟩ Criterion 2 - Criterion 24: ⟨0.69, 0⟩ Criterion 2 - Criterion 27: ⟨0.69, 0⟩ Criterion 3 - Criterion 16: ⟨0.69, 0⟩ Criterion 8 - Criterion 16: ⟨0.69, 0⟩ Criterion 9 - Criterion 16: ⟨0.69, 0⟩ Criterion 10 - Criterion 16: ⟨0.69, 0⟩ Criterion 12 - Criterion 16: ⟨0.69, 0⟩	**59**

Type of correlations	Pairs	Nr. of pairs of criteria
	Criterion 13 - Criterion 16: ⟨0.69, 0⟩ Criterion 15 - Criterion 16: ⟨0.69, 0⟩ Criterion 16 - Criterion 17: ⟨0.69, 0⟩ Criterion 16 - Criterion 21: ⟨0.69, 0⟩ Criterion 16 - Criterion 24: ⟨0.69, 0⟩ Criterion 16 - Criterion 27: ⟨0.69, 0⟩ Criterion 1 - Criterion 18: ⟨0.74, 0.09⟩ Criterion 13 - Criterion 17: ⟨0.74, 0.09⟩ Criterion 1 - Criterion 20: ⟨0.69, 0.09⟩ Criterion 17 - Criterion 21: ⟨0.69, 0.09⟩ Criterion 9 - Criterion 12: ⟨0.74, 0.17⟩ Criterion 9 - Criterion 15: ⟨0.74, 0.17⟩ Criterion 12 - Criterion 24: ⟨0.74, 0.17⟩ Criterion 15 - Criterion 24: ⟨0.74, 0.17⟩ Criterion 8 - Criterion 12: ⟨0.69, 0.17⟩ Criterion 8 - Criterion 15: ⟨0.69, 0.17⟩ Criterion 10 - Criterion 12: ⟨0.69, 0.17⟩ Criterion 10 - Criterion 15: ⟨0.69, 0.17⟩ Criterion 12 - Criterion 27: ⟨0.69, 0.17⟩ Criterion 15 - Criterion 27: ⟨0.69, 0.17⟩ Criterion 9 - Criterion 13: ⟨0.74, 0.26⟩ Criterion 13 - Criterion 24: ⟨0.74, 0.26⟩ Criterion 3 - Criterion 12: ⟨0.69, 0.23⟩ Criterion 3 - Criterion 15: ⟨0.69, 0.23⟩ Criterion 3 - Criterion 21: ⟨0.69, 0.26⟩ Criterion 8 - Criterion 13: ⟨0.69, 0.26⟩ Criterion 8 - Criterion 21: ⟨0.69, 0.26⟩ Criterion 9 - Criterion 21: ⟨0.69, 0.26⟩ Criterion 10 - Criterion 13: ⟨0.69, 0.26⟩ Criterion 10 - Criterion 21: ⟨0.69, 0.26⟩ Criterion 13 - Criterion 27: ⟨0.69, 0.26⟩ Criterion 18 - Criterion 29: ⟨0.69, 0.26⟩ Criterion 18 - Criterion 30: ⟨0.69, 0.26⟩ Criterion 19 - Criterion 20: ⟨0.69, 0.26⟩ Criterion 20 - Criterion 29: ⟨0.69, 0.26⟩ Criterion 20 - Criterion 30: ⟨0.69, 0.26⟩ Criterion 21 - Criterion 24: ⟨0.69, 0.26⟩ Criterion 21 - Criterion 27: ⟨0.69, 0.26⟩ Criterion 3 - Criterion 13: ⟨0.69, 0.31⟩ Criterion 18 - Criterion 19: ⟨0.69, 0.31⟩	
dissonance	Criterion 9 - Criterion 28: ⟨0.66, 0⟩ Criterion 24 - Criterion 28: ⟨0.66, 0⟩ Criterion 3 - Criterion 11: ⟨0.6, 0⟩ Criterion 4 - Criterion 7: ⟨0.6, 0⟩ Criterion 4 - Criterion 11: ⟨0.6, 0⟩ Criterion 4 - Criterion 28: ⟨0.6, 0⟩ Criterion 5 - Criterion 7: ⟨0.6, 0⟩ Criterion 5 - Criterion 11: ⟨0.6, 0⟩ Criterion 5 - Criterion 28: ⟨0.6, 0⟩ Criterion 6 - Criterion 7: ⟨0.6, 0⟩ Criterion 6 - Criterion 11: ⟨0.6, 0⟩ Criterion 7 - Criterion 18: ⟨0.6, 0⟩ Criterion 7 - Criterion 20: ⟨0.6, 0⟩ Criterion 7 - Criterion 26: ⟨0.6, 0⟩ Criterion 8 - Criterion 11: ⟨0.6, 0⟩ Criterion 8 - Criterion 28: ⟨0.6, 0⟩ Criterion 9 - Criterion 11: ⟨0.6, 0⟩ Criterion 10 - Criterion 11: ⟨0.6, 0⟩ Criterion 10 - Criterion 28: ⟨0.6, 0⟩ Criterion 11 - Criterion 24: ⟨0.6, 0⟩ Criterion 11 - Criterion 26: ⟨0.6, 0⟩ Criterion 11 - Criterion 27: ⟨0.6, 0⟩ Criterion 11 - Criterion 28: ⟨0.6, 0⟩ Criterion 13 - Criterion 14: ⟨0.6, 0⟩ Criterion 14 - Criterion 21: ⟨0.6, 0⟩ Criterion 14 - Criterion 22: ⟨0.6, 0⟩ Criterion 14 - Criterion 23: ⟨0.6, 0⟩ Criterion 27 - Criterion 28: ⟨0.6, 0⟩ Criterion 3 - Criterion 28: ⟨0.6, 0.06⟩ Criterion 6 - Criterion 28: ⟨0.6, 0.06⟩ Criterion 26 - Criterion 28: ⟨0.6, 0.06⟩ Criterion 3 - Criterion 6: ⟨0.66, 0.34⟩	**73**

Type of correlations	Pairs	Nr. of pairs of criteria
	Criterion 3 - Criterion 26: ⟨0.66, 0.34⟩ Criterion 6 - Criterion 18: ⟨0.66, 0.34⟩ Criterion 18 - Criterion 26: ⟨0.66, 0.34⟩ Criterion 3 - Criterion 4: ⟨0.6, 0.34⟩ Criterion 3 - Criterion 5: ⟨0.6, 0.34⟩ Criterion 4 - Criterion 8: ⟨0.6, 0.34⟩ Criterion 4 - Criterion 9: ⟨0.6, 0.34⟩ Criterion 4 - Criterion 10: ⟨0.6, 0.34⟩ Criterion 4 - Criterion 18: ⟨0.6, 0.34⟩ Criterion 4 - Criterion 20: ⟨0.6, 0.34⟩ Criterion 4 - Criterion 24: ⟨0.6, 0.34⟩ Criterion 4 - Criterion 27: ⟨0.6, 0.34⟩ Criterion 5 - Criterion 8: ⟨0.6, 0.34⟩ Criterion 5 - Criterion 9: ⟨0.6, 0.34⟩ Criterion 5 - Criterion 10: ⟨0.6, 0.34⟩ Criterion 5 - Criterion 18: ⟨0.6, 0.34⟩ Criterion 5 - Criterion 20: ⟨0.6, 0.34⟩ Criterion 5 - Criterion 24: ⟨0.6, 0.34⟩ Criterion 5 - Criterion 27: ⟨0.6, 0.34⟩ Criterion 6 - Criterion 8: ⟨0.6, 0.34⟩ Criterion 6 - Criterion 10: ⟨0.6, 0.34⟩ Criterion 6 - Criterion 20: ⟨0.6, 0.34⟩ Criterion 6 - Criterion 27: ⟨0.6, 0.34⟩ Criterion 8 - Criterion 26: ⟨0.6, 0.34⟩ Criterion 10 - Criterion 26: ⟨0.6, 0.34⟩ Criterion 13 - Criterion 23: ⟨0.6, 0.34⟩ Criterion 19 - Criterion 23: ⟨0.6, 0.34⟩ Criterion 20 - Criterion 26: ⟨0.6, 0.34⟩ Criterion 21 - Criterion 22: ⟨0.6, 0.34⟩ Criterion 21 - Criterion 23: ⟨0.6, 0.34⟩ Criterion 22 - Criterion 29: ⟨0.6, 0.34⟩ Criterion 22 - Criterion 30: ⟨0.6, 0.34⟩ Criterion 23 - Criterion 29: ⟨0.6, 0.34⟩ Criterion 23 - Criterion 30: ⟨0.6, 0.34⟩ Criterion 26 - Criterion 27: ⟨0.6, 0.34⟩ Criterion 6 - Criterion 9: ⟨0.6, 0.4⟩ Criterion 6 - Criterion 24: ⟨0.6, 0.4⟩ Criterion 9 - Criterion 26: ⟨0.6, 0.4⟩ Criterion 13 - Criterion 22: ⟨0.6, 0.4⟩ Criterion 19 - Criterion 22: ⟨0.6, 0.4⟩ Criterion 24 - Criterion 26: ⟨0.6, 0.4⟩	
strong dissonance	Criterion 12 - Criterion 14: ⟨0.51, 0⟩ Criterion 14 - Criterion 15: ⟨0.51, 0⟩ Criterion 17 - Criterion 28: ⟨0.49, 0⟩ Criterion 3 - Criterion 25: ⟨0.46, 0⟩ Criterion 6 - Criterion 25: ⟨0.46, 0⟩ Criterion 25 - Criterion 26: ⟨0.46, 0⟩ Criterion 11 - Criterion 17: ⟨0.43, 0⟩ Criterion 4 - Criterion 25: ⟨0.4, 0⟩ Criterion 5 - Criterion 25: ⟨0.4, 0⟩ Criterion 8 - Criterion 25: ⟨0.4, 0⟩ Criterion 10 - Criterion 25: ⟨0.4, 0⟩ Criterion 11 - Criterion 25: ⟨0.4, 0⟩ Criterion 25 - Criterion 27: ⟨0.4, 0⟩ Criterion 2 - Criterion 11: ⟨0.34, 0⟩ Criterion 2 - Criterion 14: ⟨0.34, 0⟩ Criterion 2 - Criterion 28: ⟨0.34, 0⟩ Criterion 9 - Criterion 25: ⟨0.4, 0.06⟩ Criterion 11 - Criterion 16: ⟨0.34, 0⟩ Criterion 14 - Criterion 16: ⟨0.34, 0⟩ Criterion 16 - Criterion 28: ⟨0.34, 0⟩ Criterion 24 - Criterion 25: ⟨0.4, 0.06⟩ Criterion 25 - Criterion 28: ⟨0.4, 0.06⟩ Criterion 1 - Criterion 7: ⟨0.34, 0.09⟩ Criterion 7 - Criterion 11: ⟨0.26, 0⟩ Criterion 7 - Criterion 28: ⟨0.26, 0⟩ Criterion 14 - Criterion 17: ⟨0.34, 0.09⟩ Criterion 2 - Criterion 25: ⟨0.23, 0⟩ Criterion 12 - Criterion 28: ⟨0.4, 0.17⟩ Criterion 15 - Criterion 28: ⟨0.4, 0.17⟩ Criterion 16 - Criterion 25: ⟨0.23, 0⟩ Criterion 7 - Criterion 25: ⟨0.17, 0⟩	**115**

Type of correlations	Pairs	Nr. of pairs of criteria
	Criterion 11 - Criterion 12: ⟨0.34, 0.17⟩ Criterion 11 - Criterion 15: ⟨0.34, 0.17⟩ Criterion 17 - Criterion 25: ⟨0.23, 0.06⟩ Criterion 12 - Criterion 23: ⟨0.51, 0.34⟩ Criterion 15 - Criterion 23: ⟨0.51, 0.34⟩ Criterion 13 - Criterion 28: ⟨0.4, 0.26⟩ Criterion 1 - Criterion 22: ⟨0.49, 0.34⟩ Criterion 12 - Criterion 22: ⟨0.51, 0.4⟩ Criterion 15 - Criterion 22: ⟨0.51, 0.4⟩ Criterion 3 - Criterion 14: ⟨0.34, 0.26⟩ Criterion 7 - Criterion 19: ⟨0.34, 0.26⟩ Criterion 7 - Criterion 29: ⟨0.34, 0.26⟩ Criterion 7 - Criterion 30: ⟨0.34, 0.26⟩ Criterion 8 - Criterion 14: ⟨0.34, 0.26⟩ Criterion 9 - Criterion 14: ⟨0.34, 0.26⟩ Criterion 10 - Criterion 14: ⟨0.34, 0.26⟩ Criterion 11 - Criterion 13: ⟨0.34, 0.26⟩ Criterion 11 - Criterion 21: ⟨0.34, 0.26⟩ Criterion 14 - Criterion 24: ⟨0.34, 0.26⟩ Criterion 14 - Criterion 27: ⟨0.34, 0.26⟩ Criterion 21 - Criterion 28: ⟨0.34, 0.26⟩ Criterion 1 - Criterion 23: ⟨0.43, 0.34⟩ Criterion 4 - Criterion 17: ⟨0.43, 0.34⟩ Criterion 5 - Criterion 17: ⟨0.43, 0.34⟩ Criterion 21 - Criterion 25: ⟨0.23, 0.17⟩ Criterion 6 - Criterion 17: ⟨0.43, 0.4⟩ Criterion 17 - Criterion 26: ⟨0.43, 0.4⟩ Criterion 2 - Criterion 4: ⟨0.34, 0.34⟩ Criterion 2 - Criterion 5: ⟨0.34, 0.34⟩ Criterion 2 - Criterion 6: ⟨0.34, 0.34⟩ Criterion 2 - Criterion 22: ⟨0.34, 0.34⟩ Criterion 2 - Criterion 23: ⟨0.34, 0.34⟩ Criterion 2 - Criterion 26: ⟨0.34, 0.34⟩ Criterion 4 - Criterion 16: ⟨0.34, 0.34⟩ Criterion 5 - Criterion 16: ⟨0.34, 0.34⟩ Criterion 6 - Criterion 16: ⟨0.34, 0.34⟩ Criterion 12 - Criterion 25: ⟨0.23, 0.23⟩ Criterion 13 - Criterion 25: ⟨0.23, 0.23⟩ Criterion 15 - Criterion 25: ⟨0.23, 0.23⟩ Criterion 16 - Criterion 22: ⟨0.34, 0.34⟩ Criterion 16 - Criterion 23: ⟨0.34, 0.34⟩ Criterion 16 - Criterion 26: ⟨0.34, 0.34⟩ Criterion 18 - Criterion 25: ⟨0.23, 0.23⟩ Criterion 1 - Criterion 6: ⟨0.4, 0.43⟩ Criterion 1 - Criterion 26: ⟨0.4, 0.43⟩ Criterion 20 - Criterion 25: ⟨0.17, 0.23⟩ Criterion 1 - Criterion 4: ⟨0.34, 0.43⟩ Criterion 1 - Criterion 5: ⟨0.34, 0.43⟩ Criterion 17 - Criterion 23: ⟨0.34, 0.43⟩ Criterion 3 - Criterion 7: ⟨0.26, 0.34⟩ Criterion 7 - Criterion 8: ⟨0.26, 0.34⟩ Criterion 7 - Criterion 9: ⟨0.26, 0.34⟩ Criterion 7 - Criterion 10: ⟨0.26, 0.34⟩ Criterion 7 - Criterion 24: ⟨0.26, 0.34⟩ Criterion 7 - Criterion 27: ⟨0.26, 0.34⟩ Criterion 11 - Criterion 18: ⟨0.26, 0.34⟩ Criterion 11 - Criterion 20: ⟨0.26, 0.34⟩ Criterion 14 - Criterion 19: ⟨0.26, 0.34⟩ Criterion 14 - Criterion 29: ⟨0.26, 0.34⟩ Criterion 14 - Criterion 30: ⟨0.26, 0.34⟩ Criterion 20 - Criterion 28: ⟨0.26, 0.34⟩ Criterion 17 - Criterion 22: ⟨0.34, 0.49⟩ Criterion 18 - Criterion 28: ⟨0.26, 0.4⟩ Criterion 4 - Criterion 12: ⟨0.34, 0.51⟩ Criterion 4 - Criterion 15: ⟨0.34, 0.51⟩ Criterion 5 - Criterion 12: ⟨0.34, 0.51⟩ Criterion 5 - Criterion 15: ⟨0.34, 0.51⟩ Criterion 14 - Criterion 25: ⟨0, 0.17⟩ Criterion 1 - Criterion 25: ⟨0.06, 0.23⟩ Criterion 11 - Criterion 14: ⟨0, 0.26⟩ Criterion 14 - Criterion 28: ⟨0, 0.26⟩ Criterion 1 - Criterion 14: ⟨0.09, 0.34⟩	

Type of correlations	Pairs	Nr. of pairs of criteria
	Criterion 7 - Criterion 17: ⟨0.09, 0.34⟩ Criterion 2 - Criterion 7: ⟨0, 0.34⟩ Criterion 7 - Criterion 16: ⟨0, 0.34⟩ Criterion 22 - Criterion 25: ⟨0.06, 0.4⟩ Criterion 23 - Criterion 25: ⟨0, 0.4⟩ Criterion 25 - Criterion 29: ⟨0, 0.4⟩ Criterion 25 - Criterion 30: ⟨0, 0.4⟩ Criterion 1 - Criterion 11: ⟨0, 0.43⟩ Criterion 19 - Criterion 25: ⟨0, 0.46⟩ Criterion 1 - Criterion 28: ⟨0, 0.49⟩ Criterion 7 - Criterion 12: ⟨0, 0.51⟩ Criterion 7 - Criterion 15: ⟨0, 0.51⟩	
dissonance	Criterion 3 - Criterion 22: ⟨0.4, 0.6⟩ Criterion 18 - Criterion 22: ⟨0.4, 0.6⟩ Criterion 6 - Criterion 12: ⟨0.34, 0.57⟩ Criterion 6 - Criterion 15: ⟨0.34, 0.57⟩ Criterion 12 - Criterion 26: ⟨0.34, 0.57⟩ Criterion 15 - Criterion 26: ⟨0.34, 0.57⟩ Criterion 3 - Criterion 23: ⟨0.34, 0.6⟩ Criterion 4 - Criterion 13: ⟨0.34, 0.6⟩ Criterion 4 - Criterion 19: ⟨0.34, 0.6⟩ Criterion 4 - Criterion 21: ⟨0.34, 0.6⟩ Criterion 4 - Criterion 29: ⟨0.34, 0.6⟩ Criterion 4 - Criterion 30: ⟨0.34, 0.6⟩ Criterion 5 - Criterion 13: ⟨0.34, 0.6⟩ Criterion 5 - Criterion 19: ⟨0.34, 0.6⟩ Criterion 5 - Criterion 21: ⟨0.34, 0.6⟩ Criterion 5 - Criterion 29: ⟨0.34, 0.6⟩ Criterion 5 - Criterion 30: ⟨0.34, 0.6⟩ Criterion 6 - Criterion 21: ⟨0.34, 0.6⟩ Criterion 6 - Criterion 29: ⟨0.34, 0.6⟩ Criterion 6 - Criterion 30: ⟨0.34, 0.6⟩ Criterion 8 - Criterion 22: ⟨0.34, 0.6⟩ Criterion 8 - Criterion 23: ⟨0.34, 0.6⟩ Criterion 9 - Criterion 23: ⟨0.34, 0.6⟩ Criterion 10 - Criterion 22: ⟨0.34, 0.6⟩ Criterion 10 - Criterion 23: ⟨0.34, 0.6⟩ Criterion 18 - Criterion 23: ⟨0.34, 0.6⟩ Criterion 20 - Criterion 22: ⟨0.34, 0.6⟩ Criterion 20 - Criterion 23: ⟨0.34, 0.6⟩ Criterion 21 - Criterion 26: ⟨0.34, 0.6⟩ Criterion 22 - Criterion 27: ⟨0.34, 0.6⟩ Criterion 23 - Criterion 24: ⟨0.34, 0.6⟩ Criterion 23 - Criterion 27: ⟨0.34, 0.6⟩ Criterion 26 - Criterion 29: ⟨0.34, 0.6⟩ Criterion 26 - Criterion 30: ⟨0.34, 0.6⟩ Criterion 6 - Criterion 13: ⟨0.34, 0.66⟩ Criterion 6 - Criterion 19: ⟨0.34, 0.66⟩ Criterion 9 - Criterion 22: ⟨0.34, 0.66⟩ Criterion 13 - Criterion 26: ⟨0.34, 0.66⟩ Criterion 19 - Criterion 26: ⟨0.34, 0.66⟩ Criterion 22 - Criterion 24: ⟨0.34, 0.66⟩ Criterion 19 - Criterion 28: ⟨0.06, 0.6⟩ Criterion 4 - Criterion 14: ⟨0, 0.6⟩ Criterion 5 - Criterion 14: ⟨0, 0.6⟩ Criterion 6 - Criterion 14: ⟨0, 0.6⟩ Criterion 7 - Criterion 13: ⟨0, 0.6⟩ Criterion 7 - Criterion 14: ⟨0, 0.6⟩ Criterion 7 - Criterion 21: ⟨0, 0.6⟩ Criterion 7 - Criterion 22: ⟨0, 0.6⟩ Criterion 7 - Criterion 23: ⟨0, 0.6⟩ Criterion 11 - Criterion 19: ⟨0, 0.6⟩ Criterion 11 - Criterion 22: ⟨0, 0.6⟩ Criterion 11 - Criterion 23: ⟨0, 0.6⟩ Criterion 11 - Criterion 29: ⟨0, 0.6⟩ Criterion 11 - Criterion 30: ⟨0, 0.6⟩ Criterion 14 - Criterion 18: ⟨0, 0.6⟩ Criterion 14 - Criterion 20: ⟨0, 0.6⟩ Criterion 14 - Criterion 26: ⟨0, 0.6⟩ Criterion 23 - Criterion 28: ⟨0, 0.6⟩ Criterion 28 - Criterion 29: ⟨0, 0.6⟩ Criterion 28 - Criterion 30: ⟨0, 0.6⟩	**61**

Type of correlations	Pairs	Nr. of pairs of criteria
	Criterion 22 - Criterion 28: ⟨0, 0.66⟩	
weak dissonance	Criterion 3 - Criterion 18: ⟨0.31, 0.69⟩ Criterion 13 - Criterion 19: ⟨0.31, 0.69⟩ Criterion 3 - Criterion 20: ⟨0.26, 0.69⟩ Criterion 8 - Criterion 18: ⟨0.26, 0.69⟩ Criterion 8 - Criterion 20: ⟨0.26, 0.69⟩ Criterion 9 - Criterion 20: ⟨0.26, 0.69⟩ Criterion 10 - Criterion 18: ⟨0.26, 0.69⟩ Criterion 10 - Criterion 20: ⟨0.26, 0.69⟩ Criterion 13 - Criterion 29: ⟨0.26, 0.69⟩ Criterion 13 - Criterion 30: ⟨0.26, 0.69⟩ Criterion 18 - Criterion 27: ⟨0.26, 0.69⟩ Criterion 19 - Criterion 21: ⟨0.26, 0.69⟩ Criterion 20 - Criterion 24: ⟨0.26, 0.69⟩ Criterion 20 - Criterion 27: ⟨0.26, 0.69⟩ Criterion 21 - Criterion 29: ⟨0.26, 0.69⟩ Criterion 21 - Criterion 30: ⟨0.26, 0.69⟩ Criterion 12 - Criterion 19: ⟨0.23, 0.69⟩ Criterion 15 - Criterion 19: ⟨0.23, 0.69⟩ Criterion 9 - Criterion 18: ⟨0.26, 0.74⟩ Criterion 18 - Criterion 24: ⟨0.26, 0.74⟩ Criterion 12 - Criterion 29: ⟨0.17, 0.69⟩ Criterion 12 - Criterion 30: ⟨0.17, 0.69⟩ Criterion 15 - Criterion 29: ⟨0.17, 0.69⟩ Criterion 15 - Criterion 30: ⟨0.17, 0.69⟩ Criterion 1 - Criterion 21: ⟨0.09, 0.69⟩ Criterion 17 - Criterion 20: ⟨0.09, 0.69⟩ Criterion 1 - Criterion 13: ⟨0.09, 0.74⟩ Criterion 17 - Criterion 18: ⟨0.09, 0.74⟩ Criterion 1 - Criterion 2: ⟨0, 0.69⟩ Criterion 1 - Criterion 16: ⟨0, 0.69⟩ Criterion 2 - Criterion 18: ⟨0, 0.69⟩ Criterion 2 - Criterion 19: ⟨0, 0.69⟩ Criterion 2 - Criterion 20: ⟨0, 0.69⟩ Criterion 2 - Criterion 29: ⟨0, 0.69⟩ Criterion 2 - Criterion 30: ⟨0, 0.69⟩ Criterion 16 - Criterion 18: ⟨0, 0.69⟩ Criterion 16 - Criterion 19: ⟨0, 0.69⟩ Criterion 16 - Criterion 20: ⟨0, 0.69⟩ Criterion 16 - Criterion 29: ⟨0, 0.69⟩ Criterion 16 - Criterion 30: ⟨0, 0.69⟩ Criterion 1 - Criterion 12: ⟨0, 0.74⟩ Criterion 1 - Criterion 15: ⟨0, 0.74⟩	**42**
weak negative consonance	Criterion 1 - Criterion 3: ⟨0.06, 0.77⟩ Criterion 17 - Criterion 19: ⟨0.06, 0.77⟩ Criterion 1 - Criterion 8: ⟨0, 0.77⟩	**10**

Type of correlations	Pairs	Nr. of pairs of criteria
	Criterion 1 - Criterion 10: ⟨0, 0.77⟩ Criterion 1 - Criterion 27: ⟨0, 0.77⟩ Criterion 17 - Criterion 29: ⟨0, 0.77⟩ Criterion 17 - Criterion 30: ⟨0, 0.77⟩ Criterion 1 - Criterion 9: ⟨0, 0.83⟩ Criterion 1 - Criterion 17: ⟨0, 0.83⟩ Criterion 1 - Criterion 24: ⟨0, 0.83⟩	
negative consonance	Criterion 12 - Criterion 20: ⟨0, 0.86⟩ Criterion 15 - Criterion 20: ⟨0, 0.86⟩ Criterion 6 - Criterion 22: ⟨0.06, 0.94⟩ Criterion 9 - Criterion 19: ⟨0.06, 0.94⟩ Criterion 19 - Criterion 24: ⟨0.06, 0.94⟩ Criterion 22 - Criterion 26: ⟨0.06, 0.94⟩ Criterion 12 - Criterion 18: ⟨0, 0.91⟩ Criterion 15 - Criterion 18: ⟨0, 0.91⟩ Criterion 3 - Criterion 29: ⟨0, 0.94⟩ Criterion 3 - Criterion 30: ⟨0, 0.94⟩ Criterion 4 - Criterion 22: ⟨0, 0.94⟩ Criterion 4 - Criterion 23: ⟨0, 0.94⟩ Criterion 5 - Criterion 22: ⟨0, 0.94⟩ Criterion 5 - Criterion 23: ⟨0, 0.94⟩ Criterion 6 - Criterion 23: ⟨0, 0.94⟩ Criterion 8 - Criterion 19: ⟨0, 0.94⟩ Criterion 8 - Criterion 29: ⟨0, 0.94⟩ Criterion 8 - Criterion 30: ⟨0, 0.94⟩ Criterion 9 - Criterion 29: ⟨0, 0.94⟩ Criterion 9 - Criterion 30: ⟨0, 0.94⟩ Criterion 10 - Criterion 19: ⟨0, 0.94⟩ Criterion 10 - Criterion 29: ⟨0, 0.94⟩ Criterion 10 - Criterion 30: ⟨0, 0.94⟩ Criterion 13 - Criterion 20: ⟨0, 0.94⟩ Criterion 18 - Criterion 21: ⟨0, 0.94⟩ Criterion 19 - Criterion 27: ⟨0, 0.94⟩ Criterion 20 - Criterion 21: ⟨0, 0.94⟩ Criterion 23 - Criterion 26: ⟨0, 0.94⟩ Criterion 24 - Criterion 29: ⟨0, 0.94⟩ Criterion 24 - Criterion 30: ⟨0, 0.94⟩ Criterion 27 - Criterion 29: ⟨0, 0.94⟩ Criterion 27 - Criterion 30: ⟨0, 0.94⟩	**32**
strong negative consonance	Criterion 3 - Criterion 19: ⟨0, 1⟩ Criterion 13 - Criterion 18: ⟨0, 1⟩	**2**

When comparing regular ICA with the weighted variant, we get the following counts:

Type of correlations	ICA – no weights	ICA with object weights
strong positive consonance	**2**	**2**
positive consonance	**0**	**30**
weak positive consonance	**34**	**2**
weak dissonance	**0**	**9**
dissonance	**70**	**59**
strong dissonance	**241**	**73**
dissonance	**48**	**115**
weak dissonance	**0**	**61**
weak negative consonance	**38**	**42**
negative consonance	**0**	**10**
strong negative consonance	**2**	**32**

The IFPs from the results can be visualized on the IF triangle like this:

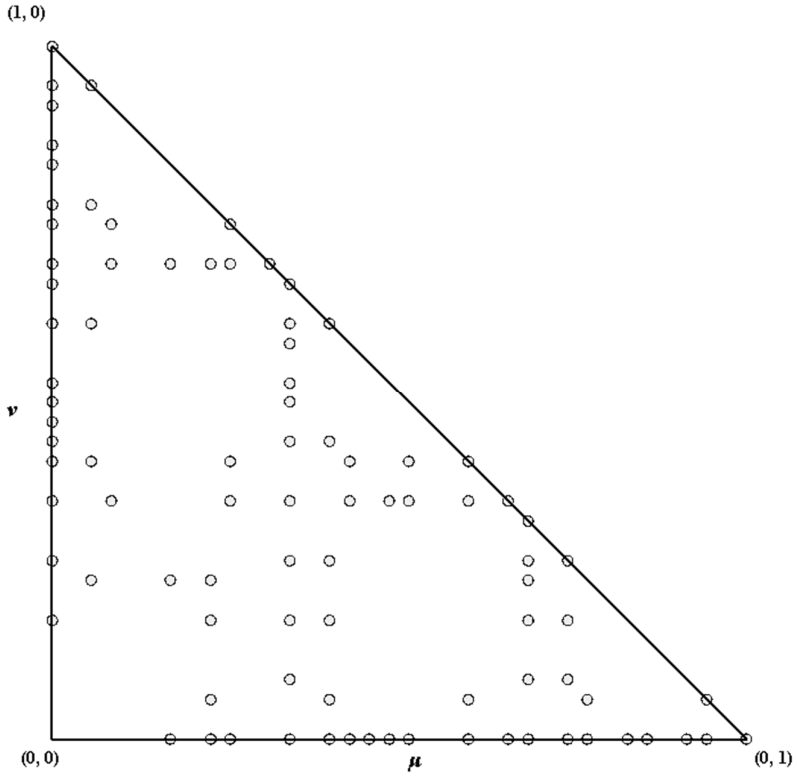

Figure 2. Intuitionistic Fuzzy Triangle – results for Constant conv. (65%)

2.2 Input data – Constant Coke (1,9)

Now we will perform ICA with object weights on a different set of data. The comparison between the interpolated yields at constant conversion is usually made to assess the difference in the selectivities of the distinct operating scenarios, while that at constant coke is performed to evaluate the expected performance of the commercial heat balanced FCC unit which is known to operate at constant coke yield [2]. Table 2.1. presents the yields interpolated at constant coke of 1.9 wt.% for the four investigated cases.

Table 4. FCC Yields, hydrocarbon composition, and RON, and MON of cracked naphtha (CN) interpolatated at constant coke yield of 1.9 wt.%.

			FUTURA 7 0 + 2% SLO	**FUTURA 70+**	**E-CAT NEF + 2% SLO**	**ECAT**
Nr	**Weight (Criteria)**		**P42.157.2**	**P42.157.1**	**96301122**	**96301121**
		Weight (Objects)	**1**	**2**	**3**	**4**
1	5	Conversion	58	57	51	49
2	1	CTO	3.4	3.2	2.9	2.5
3	2	Hydrogen	0.062	0.060	0.090	0.081
4	1	Dry gas	1.8	1.7	1.4	1.3
5	4	C3=	3.2	3.2	22.8	2.7
6	1	C3	0.64	0.6	0.54	0.49
7	1	Total C3	3.9	3.8	3.3	3.2

8	5	i-C4=	1.0	1.0	0.9	0.9
9	5	i-C4	2.3	2.2	1.9	1.7
10	1	n-C4	0.52	0.49	0.43	0.40
11	5	Total C4='s	4.2	4.1	3.6	3.5
12	3	Total C4	6.9	6.7	5.9	5.6
13	5	C3= + C4=	7.4	7.3	6.4	6.2
14	2	LPG	10.8	10.5	9.2	8.8
15	2	LPG Olef.	68.4	69.1	69.1	70.1
16	6	CN	43.8	42.7	38.3	36.8
17	6	LC0 (221-338°C)	18.7	18.6	18.2	18.1
18	1	HCO (338°C+)	22.9	24.5	30.9	33.1
19	1	CN n-Paraffins	4.0	4.0	3.8	3.8
20	5	CN i-Paraffins	32.7	32.6	20.8	29.7
21	4	CN Aromatics	28.0	27.6	28.0	29.0
22	4	CN Naphthenes	10.5	10.9	11.2	11.6
23	4	CN Olefins	21.4	22	23.0	23.5
24	7	GC-MON	79.3	79.2	79.4	79.3
25	7	GC-RON	0.000	0.000	1.000	0.600

After performing ICA with the object weights, we get the resulting IFPs presented in Table 5. This time, we have 25 criteria evaluating 4 objects, resulting in 300 criteria pairs.

Table 5. Intuitionistic fuzzy pairs after applying ICA on the data for Constant Coke (1,9)

	1	2	3	4	5	6	7	8	9	10
1.Conversion		⟨1,0⟩	⟨0.4,0.6⟩	⟨1,0⟩	⟨0.69,0.26⟩	⟨1,0⟩	⟨1,0⟩	⟨0.6,0⟩	⟨1,0⟩	⟨1,0⟩
2.CTO	⟨1,0⟩		⟨0.4,0.6⟩	⟨1,0⟩	⟨0.69,0.26⟩	⟨1,0⟩	⟨1,0⟩	⟨0.6,0⟩	⟨1,0⟩	⟨1,0⟩
3.Hydrgen	⟨0.4,0.6⟩	⟨0.4,0.6⟩		⟨0.4,0.6⟩	⟨0.6,0.34⟩	⟨0.4,0.6⟩	⟨0.4,0.6⟩	⟨0,0.6⟩	⟨0.4,0.6⟩	⟨0.4,0.6⟩
4.Dry gas	⟨1,0⟩	⟨1,0⟩	⟨0.4,0.6⟩		⟨0.69,0.26⟩	⟨1,0⟩	⟨1,0⟩	⟨0.6,0⟩	⟨1,0⟩	⟨1,0⟩
5.C3=	⟨0.69,0.26⟩	⟨0.69,0.26⟩	⟨0.6,0.34⟩	⟨0.69,0.26⟩		⟨0.69,0.26⟩	⟨0.69,0.26⟩	⟨0.34,0.26⟩	⟨0.69,0.26⟩	⟨0.69,0.26⟩
6.C3	⟨1,0⟩	⟨1,0⟩	⟨0.4,0.6⟩	⟨1,0⟩	⟨0.69,0.26⟩		⟨1,0⟩	⟨0.6,0⟩	⟨1,0⟩	⟨1,0⟩
7.Total C3	⟨1,0⟩	⟨1,0⟩	⟨0.4,0.6⟩	⟨1,0⟩	⟨0.69,0.26⟩	⟨1,0⟩		⟨0.6,0⟩	⟨1,0⟩	⟨1,0⟩
8.i-C4=	⟨0.6,0⟩	⟨0.6,0⟩	⟨0,0.6⟩	⟨0.6,0⟩	⟨0.34,0.26⟩	⟨0.6,0⟩	⟨0.6,0⟩		⟨0.6,0⟩	⟨0.6,0⟩
9.i-C4	⟨1,0⟩	⟨1,0⟩	⟨0.4,0.6⟩	⟨1,0⟩	⟨0.69,0.26⟩	⟨1,0⟩	⟨1,0⟩	⟨0.6,0⟩		⟨1,0⟩
10.n-C4	⟨1,0⟩	⟨1,0⟩	⟨0.4,0.6⟩	⟨1,0⟩	⟨0.69,0.26⟩	⟨1,0⟩	⟨1,0⟩	⟨0.6,0⟩	⟨1,0⟩	
11.Total C4='s	⟨1,0⟩	⟨1,0⟩	⟨0.4,0.6⟩	⟨1,0⟩	⟨0.69,0.26⟩	⟨1,0⟩	⟨1,0⟩	⟨0.6,0⟩	⟨1,0⟩	⟨1,0⟩
12.Total C4	⟨1,0⟩	⟨1,0⟩	⟨0.4,0.6⟩	⟨1,0⟩	⟨0.69,0.26⟩	⟨1,0⟩	⟨1,0⟩	⟨0.6,0⟩	⟨1,0⟩	⟨1,0⟩
13.C3= + C4=	⟨1,0⟩	⟨1,0⟩	⟨0.4,0.6⟩	⟨1,0⟩	⟨0.69,0.26⟩	⟨1,0⟩	⟨1,0⟩	⟨0.6,0⟩	⟨1,0⟩	⟨1,0⟩
14.LPG	⟨1,0⟩	⟨1,0⟩	⟨0.4,0.6⟩	⟨1,0⟩	⟨0.69,0.26⟩	⟨1,0⟩	⟨1,0⟩	⟨0.6,0⟩	⟨1,0⟩	⟨1,0⟩
15.LPG Olef.	⟨0,0.83⟩	⟨0,0.83⟩	⟨0.43,0.4⟩	⟨0,0.83⟩	⟨0.09,0.69⟩	⟨0,0.83⟩	⟨0,0.83⟩	⟨0,0.43⟩	⟨0,0.83⟩	⟨0,0.83⟩
16.CN	⟨1,0⟩	⟨1,0⟩	⟨0.4,0.6⟩	⟨1,0⟩	⟨0.69,0.26⟩	⟨1,0⟩	⟨1,0⟩	⟨0.6,0⟩	⟨1,0⟩	⟨1,0⟩
17.LC0 (221-338°C)	⟨1,0⟩	⟨1,0⟩	⟨0.4,0.6⟩	⟨1,0⟩	⟨0.69,0.26⟩	⟨1,0⟩	⟨1,0⟩	⟨0.6,0⟩	⟨1,0⟩	⟨1,0⟩
18.HCO (338°C+)	⟨0,1⟩	⟨0,1⟩	⟨0.6,0.4⟩	⟨0,1⟩	⟨0.26,0.69⟩	⟨0,1⟩	⟨0,1⟩	⟨0,0.6⟩	⟨0,1⟩	⟨0,1⟩
19.CN n-Paraffins	⟨0.6,0⟩	⟨0.6,0⟩	⟨0,0.6⟩	⟨0.6,0⟩	⟨0.34,0.26⟩	⟨0.6,0⟩	⟨0.6,0⟩	⟨0.6,0⟩	⟨0.6,0⟩	⟨0.6,0⟩
20.CN i-Paraffins	⟨0.66,0.34⟩	⟨0.66,0.34⟩	⟨0.06,0.94⟩	⟨0.66,0.34⟩	⟨0.34,0.6⟩	⟨0.66,0.34⟩	⟨0.66,0.34⟩	⟨0.6,0⟩	⟨0.66,0.34⟩	⟨0.66,0.34⟩
21.CN Aromatics	⟨0.06,0.86⟩	⟨0.06,0.86⟩	⟨0.57,0.34⟩	⟨0.06,0.86⟩	⟨0.17,0.69⟩	⟨0.06,0.86⟩	⟨0.06,0.86⟩	⟨0,0.51⟩	⟨0.06,0.86⟩	⟨0.06,0.86⟩
22.CN Naphthenes	⟨0,1⟩	⟨0,1⟩	⟨0.6,0.4⟩	⟨0,1⟩	⟨0.26,0.69⟩	⟨0,1⟩	⟨0,1⟩	⟨0,0.6⟩	⟨0,1⟩	⟨0,1⟩
23.CN Olefins	⟨0,1⟩	⟨0,1⟩	⟨0.6,0.4⟩	⟨0,1⟩	⟨0.26,0.69⟩	⟨0,1⟩	⟨0,1⟩	⟨0,0.6⟩	⟨0,1⟩	⟨0,1⟩
24.GC-MON	⟨0.4,0.49⟩	⟨0.4,0.49⟩	⟨0.89,0⟩	⟨0.4,0.49⟩	⟨0.6,0.23⟩	⟨0.4,0.49⟩	⟨0.4,0.49⟩	⟨0,0.49⟩	⟨0.4,0.49⟩	⟨0.4,0.49⟩
25.GC-RON	⟨0.34,0.6⟩	⟨0.34,0.6⟩	⟨0.94,0⟩	⟨0.34,0.6⟩	⟨0.6,0.34⟩	⟨0.34,0.6⟩	⟨0.34,0.6⟩	⟨0,0.6⟩	⟨0.34,0.6⟩	⟨0.34,0.6⟩

Contd. columns 11-20

	11	12	13	14	15	16	17	18	19	20
1.Conversion	⟨1,0⟩	⟨1,0⟩	⟨1,0⟩	⟨1,0⟩	⟨0,0.83⟩	⟨1,0⟩	⟨1,0⟩	⟨0,1⟩	⟨0.6,0⟩	⟨0.66,0.34⟩
2.CTO	⟨1,0⟩	⟨1,0⟩	⟨1,0⟩	⟨1,0⟩	⟨0,0.83⟩	⟨1,0⟩	⟨1,0⟩	⟨0,1⟩	⟨0.6,0⟩	⟨0.66,0.34⟩
3.Hydrgen	⟨0.4,0.6⟩	⟨0.4,0.6⟩	⟨0.4,0.6⟩	⟨0.4,0.6⟩	⟨0.43,0.4⟩	⟨0.4,0.6⟩	⟨0.4,0.6⟩	⟨0.6,0.4⟩	⟨0,0.6⟩	⟨0.06,0.94⟩
4.Dry gas	⟨1,0⟩	⟨1,0⟩	⟨1,0⟩	⟨1,0⟩	⟨0,0.83⟩	⟨1,0⟩	⟨1,0⟩	⟨0,1⟩	⟨0.6,0⟩	⟨0.66,0.34⟩
5.C3=	⟨0.69,0.26⟩	⟨0.69,0.26⟩	⟨0.69,0.26⟩	⟨0.69,0.26⟩	⟨0.09,0.69⟩	⟨0.69,0.26⟩	⟨0.69,0.26⟩	⟨0.26,0.69⟩	⟨0.34,0.26⟩	⟨0.34,0.6⟩
6.C3	⟨1,0⟩	⟨1,0⟩	⟨1,0⟩	⟨1,0⟩	⟨0,0.83⟩	⟨1,0⟩	⟨1,0⟩	⟨0,1⟩	⟨0.6,0⟩	⟨0.66,0.34⟩
7.Total C3	⟨1,0⟩	⟨1,0⟩	⟨1,0⟩	⟨1,0⟩	⟨0,0.83⟩	⟨1,0⟩	⟨1,0⟩	⟨0,1⟩	⟨0.6,0⟩	⟨0.66,0.34⟩
8.i-C4=	⟨0.6,0⟩	⟨0.6,0⟩	⟨0.6,0⟩	⟨0.6,0⟩	⟨0,0.43⟩	⟨0.6,0⟩	⟨0.6,0⟩	⟨0,0.6⟩	⟨0.6,0⟩	⟨0.6,0⟩
9.i-C4	⟨1,0⟩	⟨1,0⟩	⟨1,0⟩	⟨1,0⟩	⟨0,0.83⟩	⟨1,0⟩	⟨1,0⟩	⟨0,1⟩	⟨0.6,0⟩	⟨0.66,0.34⟩
10.n-C4	⟨1,0⟩	⟨1,0⟩	⟨1,0⟩	⟨1,0⟩	⟨0,0.83⟩	⟨1,0⟩	⟨1,0⟩	⟨0,1⟩	⟨0.6,0⟩	⟨0.66,0.34⟩
11.Total C4='s		⟨1,0⟩	⟨1,0⟩	⟨1,0⟩	⟨0,0.83⟩	⟨1,0⟩	⟨1,0⟩	⟨0,1⟩	⟨0.6,0⟩	⟨0.66,0.34⟩
12.Total C4	⟨1,0⟩		⟨1,0⟩	⟨1,0⟩	⟨0,0.83⟩	⟨1,0⟩	⟨1,0⟩	⟨0,1⟩	⟨0.6,0⟩	⟨0.66,0.34⟩
13.C3= + C4=	⟨1,0⟩	⟨1,0⟩		⟨1,0⟩	⟨0,0.83⟩	⟨1,0⟩	⟨1,0⟩	⟨0,1⟩	⟨0.6,0⟩	⟨0.66,0.34⟩
14.LPG	⟨1,0⟩	⟨1,0⟩	⟨1,0⟩		⟨0,0.83⟩	⟨1,0⟩	⟨1,0⟩	⟨0,1⟩	⟨0.6,0⟩	⟨0.66,0.34⟩
15.LPG Olef.	⟨0,0.83⟩	⟨0,0.83⟩	⟨0,0.83⟩	⟨0,0.83⟩		⟨0,0.83⟩	⟨0,0.83⟩	⟨0.83,0⟩	⟨0,0.43⟩	⟨0.34,0.49⟩
16.CN	⟨1,0⟩	⟨1,0⟩	⟨1,0⟩	⟨1,0⟩	⟨0,0.83⟩		⟨1,0⟩	⟨0,1⟩	⟨0.6,0⟩	⟨0.66,0.34⟩
17.LC0 (221-338°C	⟨1,0⟩	⟨1,0⟩	⟨1,0⟩	⟨1,0⟩	⟨0,0.83⟩	⟨1,0⟩		⟨0,1⟩	⟨0.6,0⟩	⟨0.66,0.34⟩
18.HCO (338°C+)	⟨0,1⟩	⟨0,1⟩	⟨0,1⟩	⟨0,1⟩	⟨0.83,0⟩	⟨0,1⟩	⟨0,1⟩		⟨0,0.6⟩	⟨0.34,0.66⟩
19.CN n-Paraffins	⟨0.6,0⟩	⟨0.6,0⟩	⟨0.6,0⟩	⟨0.6,0⟩	⟨0,0.43⟩	⟨0.6,0⟩	⟨0.6,0⟩	⟨0,0.6⟩		⟨0.6,0⟩
20.CN i-Paraffins	⟨0.66,0.34⟩	⟨0.66,0.34⟩	⟨0.66,0.34⟩	⟨0.66,0.34⟩	⟨0.34,0.49⟩	⟨0.66,0.34⟩	⟨0.66,0.34⟩	⟨0.34,0.66⟩	⟨0.6,0⟩	
21.CN Aromatics	⟨0.06,0.86⟩	⟨0.06,0.86⟩	⟨0.06,0.86⟩	⟨0.06,0.86⟩	⟨0.69,0.06⟩	⟨0.06,0.86⟩	⟨0.06,0.86⟩	⟨0.86,0.06⟩	⟨0,0.51⟩	⟨0.4,0.51⟩
22.CN Naphthenes	⟨0,1⟩	⟨0,1⟩	⟨0,1⟩	⟨0,1⟩	⟨0.83,0⟩	⟨0,1⟩	⟨0,1⟩	⟨1,0⟩	⟨0,0.6⟩	⟨0.34,0.66⟩
23.CN Olefins	⟨0,1⟩	⟨0,1⟩	⟨0,1⟩	⟨0,1⟩	⟨0.83,0⟩	⟨0,1⟩	⟨0,1⟩	⟨1,0⟩	⟨0,0.6⟩	⟨0.34,0.66⟩
24.GC-MON	⟨0.4,0.49⟩	⟨0.4,0.49⟩	⟨0.4,0.49⟩	⟨0.4,0.49⟩	⟨0.31,0.4⟩	⟨0.4,0.49⟩	⟨0.4,0.49⟩	⟨0.49,0.4⟩	⟨0,0.49⟩	⟨0.06,0.83⟩
25.GC-RON	⟨0.34,0.6⟩	⟨0.34,0.6⟩	⟨0.34,0.6⟩	⟨0.34,0.6⟩	⟨0.43,0.34⟩	⟨0.34,0.6⟩	⟨0.34,0.6⟩	⟨0.6,0.34⟩	⟨0,0.6⟩	⟨0,0.94⟩

Contd. columns 21-25

	21	22	23	24	25
1.Conversion	⟨0.06,0.86⟩	⟨0,1⟩	⟨0,1⟩	⟨0.4,0.49⟩	⟨0.34,0.6⟩
2.CTO	⟨0.06,0.86⟩	⟨0,1⟩	⟨0,1⟩	⟨0.4,0.49⟩	⟨0.34,0.6⟩
3.Hydrgen	⟨0.57,0.34⟩	⟨0.6,0.4⟩	⟨0.6,0.4⟩	⟨0.89,0⟩	⟨0.94,0⟩
4.Dry gas	⟨0.06,0.86⟩	⟨0,1⟩	⟨0,1⟩	⟨0.4,0.49⟩	⟨0.34,0.6⟩
5.C3=	⟨0.17,0.69⟩	⟨0.26,0.69⟩	⟨0.26,0.69⟩	⟨0.6,0.23⟩	⟨0.6,0.34⟩
6.C3	⟨0.06,0.86⟩	⟨0,1⟩	⟨0,1⟩	⟨0.4,0.49⟩	⟨0.34,0.6⟩
7.Total C3	⟨0.06,0.86⟩	⟨0,1⟩	⟨0,1⟩	⟨0.4,0.49⟩	⟨0.34,0.6⟩
8.i-C4=	⟨0,0.51⟩	⟨0,0.6⟩	⟨0,0.6⟩	⟨0,0.49⟩	⟨0,0.6⟩
9.i-C4	⟨0.06,0.86⟩	⟨0,1⟩	⟨0,1⟩	⟨0.4,0.49⟩	⟨0.34,0.6⟩
10.n-C4	⟨0.06,0.86⟩	⟨0,1⟩	⟨0,1⟩	⟨0.4,0.49⟩	⟨0.34,0.6⟩
11.Total C4='s	⟨0.06,0.86⟩	⟨0,1⟩	⟨0,1⟩	⟨0.4,0.49⟩	⟨0.34,0.6⟩
12.Total C4	⟨0.06,0.86⟩	⟨0,1⟩	⟨0,1⟩	⟨0.4,0.49⟩	⟨0.34,0.6⟩
13.C3= + C4=	⟨0.06,0.86⟩	⟨0,1⟩	⟨0,1⟩	⟨0.4,0.49⟩	⟨0.34,0.6⟩
14.LPG	⟨0.06,0.86⟩	⟨0,1⟩	⟨0,1⟩	⟨0.4,0.49⟩	⟨0.34,0.6⟩
15.LPG Olef.	⟨0.69,0.06⟩	⟨0.83,0⟩	⟨0.83,0⟩	⟨0.31,0.4⟩	⟨0.43,0.34⟩
16.CN	⟨0.06,0.86⟩	⟨0,1⟩	⟨0,1⟩	⟨0.4,0.49⟩	⟨0.34,0.6⟩
17.LC0 (221-338°C)	⟨0.06,0.86⟩	⟨0,1⟩	⟨0,1⟩	⟨0.4,0.49⟩	⟨0.34,0.6⟩
18.HCO (338°C+)	⟨0.86,0.06⟩	⟨1,0⟩	⟨1,0⟩	⟨0.49,0.4⟩	⟨0.6,0.34⟩
19.CN n-Paraffins	⟨0,0.51⟩	⟨0,0.6⟩	⟨0,0.6⟩	⟨0,0.49⟩	⟨0,0.6⟩
20.CN i-Paraffins	⟨0.4,0.51⟩	⟨0.34,0.66⟩	⟨0.34,0.66⟩	⟨0.06,0.83⟩	⟨0,0.94⟩

	21	22	23	24	25
21.CN Aromatics		⟨0.86,0.06⟩	⟨0.86,0.06⟩	⟨0.46,0.34⟩	⟨0.51,0.34⟩
22.CN Naphthenes	⟨0.86,0.06⟩		⟨1,0⟩	⟨0.49,0.4⟩	⟨0.6,0.34⟩
23.CN Olefins	⟨0.86,0.06⟩	⟨1,0⟩		⟨0.49,0.4⟩	⟨0.6,0.34⟩
24.GC-MON	⟨0.46,0.34⟩	⟨0.49,0.4⟩	⟨0.49,0.4⟩		⟨0.83,0⟩
25.GC-RON	⟨0.51,0.34⟩	⟨0.6,0.34⟩	⟨0.6,0.34⟩	⟨0.83,0⟩	

The criteria pairs are sorted by type of correlation in Table 6. The results give the following groupings:

- 81 criteria pairs are in strong positive consonance and 39 in strong negative consonance;
- 5 pairs are in positive consonance and 15 – in negative consonance
- 4 are in weak positive consonance and 14 – in weak negative consonance;
- 14 pairs are in weak dissonance on the positive side and 5 – on the negative;
- 52 pairs are in dissonance on the positive side and 40 – on the negative;
- 31 pairs are in strong dissonance.

Table 6. Types of correlations for Constant Coke (1,9)

Type of correlations	Pairs	Nr. of pairs of criteria
strong positive consonance	Criterion 1 - Criterion 2: ⟨1, 0⟩ Criterion 1 - Criterion 4: ⟨1, 0⟩ Criterion 1 - Criterion 6: ⟨1, 0⟩ Criterion 1 - Criterion 7: ⟨1, 0⟩ Criterion 1 - Criterion 9: ⟨1, 0⟩ Criterion 1 - Criterion 10: ⟨1, 0⟩ Criterion 1 - Criterion 11: ⟨1, 0⟩ Criterion 1 - Criterion 12: ⟨1, 0⟩ Criterion 1 - Criterion 13: ⟨1, 0⟩ Criterion 1 - Criterion 14: ⟨1, 0⟩ Criterion 1 - Criterion 16: ⟨1, 0⟩ Criterion 1 - Criterion 17: ⟨1, 0⟩ Criterion 2 - Criterion 4: ⟨1, 0⟩ Criterion 2 - Criterion 6: ⟨1, 0⟩ Criterion 2 - Criterion 7: ⟨1, 0⟩ Criterion 2 - Criterion 9: ⟨1, 0⟩ Criterion 2 - Criterion 10: ⟨1, 0⟩ Criterion 2 - Criterion 11: ⟨1, 0⟩ Criterion 2 - Criterion 12: ⟨1, 0⟩ Criterion 2 - Criterion 13: ⟨1, 0⟩ Criterion 2 - Criterion 14: ⟨1, 0⟩ Criterion 2 - Criterion 16: ⟨1, 0⟩ Criterion 2 - Criterion 17: ⟨1, 0⟩ Criterion 4 - Criterion 6: ⟨1, 0⟩ Criterion 4 - Criterion 7: ⟨1, 0⟩ Criterion 4 - Criterion 9: ⟨1, 0⟩ Criterion 4 - Criterion 10: ⟨1, 0⟩ Criterion 4 - Criterion 11: ⟨1, 0⟩ Criterion 4 - Criterion 12: ⟨1, 0⟩ Criterion 4 - Criterion 13: ⟨1, 0⟩ Criterion 4 - Criterion 14: ⟨1, 0⟩ Criterion 4 - Criterion 16: ⟨1, 0⟩ Criterion 4 - Criterion 17: ⟨1, 0⟩ Criterion 6 - Criterion 7: ⟨1, 0⟩ Criterion 6 - Criterion 9: ⟨1, 0⟩ Criterion 6 - Criterion 10: ⟨1, 0⟩ Criterion 6 - Criterion 11: ⟨1, 0⟩ Criterion 6 - Criterion 12: ⟨1, 0⟩ Criterion 6 - Criterion 13: ⟨1, 0⟩ Criterion 6 - Criterion 14: ⟨1, 0⟩ Criterion 6 - Criterion 16: ⟨1, 0⟩ Criterion 6 - Criterion 17: ⟨1, 0⟩	**81**
	Criterion 7 - Criterion 9: ⟨1, 0⟩ Criterion 7 - Criterion 10: ⟨1, 0⟩ Criterion 7 - Criterion 11: ⟨1, 0⟩ Criterion 7 - Criterion 12: ⟨1, 0⟩ Criterion 7 - Criterion 13: ⟨1, 0⟩ Criterion 7 - Criterion 14: ⟨1, 0⟩ Criterion 7 - Criterion 16: ⟨1, 0⟩ Criterion 7 - Criterion 17: ⟨1, 0⟩ Criterion 9 - Criterion 10: ⟨1, 0⟩ Criterion 9 - Criterion 11: ⟨1, 0⟩ Criterion 9 - Criterion 12: ⟨1, 0⟩ Criterion 9 - Criterion 13: ⟨1, 0⟩ Criterion 9 - Criterion 14: ⟨1, 0⟩ Criterion 9 - Criterion 16: ⟨1, 0⟩ Criterion 9 - Criterion 17: ⟨1, 0⟩ Criterion 10 - Criterion 11: ⟨1, 0⟩ Criterion 10 - Criterion 12: ⟨1, 0⟩ Criterion 10 - Criterion 13: ⟨1, 0⟩ Criterion 10 - Criterion 14: ⟨1, 0⟩ Criterion 10 - Criterion 16: ⟨1, 0⟩ Criterion 10 - Criterion 17: ⟨1, 0⟩ Criterion 11 - Criterion 12: ⟨1, 0⟩ Criterion 11 - Criterion 13: ⟨1, 0⟩ Criterion 11 - Criterion 14: ⟨1, 0⟩ Criterion 11 - Criterion 16: ⟨1, 0⟩ Criterion 11 - Criterion 17: ⟨1, 0⟩ Criterion 12 - Criterion 13: ⟨1, 0⟩ Criterion 12 - Criterion 14: ⟨1, 0⟩ Criterion 12 - Criterion 16: ⟨1, 0⟩ Criterion 12 - Criterion 17: ⟨1, 0⟩ Criterion 13 - Criterion 14: ⟨1, 0⟩ Criterion 13 - Criterion 16: ⟨1, 0⟩ Criterion 13 - Criterion 17: ⟨1, 0⟩ Criterion 14 - Criterion 16: ⟨1, 0⟩ Criterion 14 - Criterion 17: ⟨1, 0⟩ Criterion 16 - Criterion 17: ⟨1, 0⟩ Criterion 18 - Criterion 22: ⟨1, 0⟩ Criterion 18 - Criterion 23: ⟨1, 0⟩ Criterion 22 - Criterion 23: ⟨1, 0⟩	
positive consonance	Criterion 3 - Criterion 25: ⟨0.94, 0⟩ Criterion 3 - Criterion 24: ⟨0.89, 0⟩ Criterion 18 - Criterion 21: ⟨0.86, 0.06⟩	**5**

Type of correlations	Pairs	Nr. of pairs of criteria
	Criterion 21 - Criterion 22: ⟨0.86, 0.06⟩ Criterion 21 - Criterion 23: ⟨0.86, 0.06⟩	
weak positive consonance	Criterion 15 - Criterion 18: ⟨0.83, 0⟩ Criterion 15 - Criterion 22: ⟨0.83, 0⟩ Criterion 15 - Criterion 23: ⟨0.83, 0⟩ Criterion 24 - Criterion 25: ⟨0.83, 0⟩	**4**
weak dissonance	Criterion 15 - Criterion 21: ⟨0.69, 0.06⟩ Criterion 1 - Criterion 5: ⟨0.69, 0.26⟩ Criterion 2 - Criterion 5: ⟨0.69, 0.26⟩ Criterion 4 - Criterion 5: ⟨0.69, 0.26⟩ Criterion 5 - Criterion 6: ⟨0.69, 0.26⟩ Criterion 5 - Criterion 7: ⟨0.69, 0.26⟩ Criterion 5 - Criterion 9: ⟨0.69, 0.26⟩ Criterion 5 - Criterion 10: ⟨0.69, 0.26⟩ Criterion 5 - Criterion 11: ⟨0.69, 0.26⟩ Criterion 5 - Criterion 12: ⟨0.69, 0.26⟩ Criterion 5 - Criterion 13: ⟨0.69, 0.26⟩ Criterion 5 - Criterion 14: ⟨0.69, 0.26⟩ Criterion 5 - Criterion 16: ⟨0.69, 0.26⟩ Criterion 5 - Criterion 17: ⟨0.69, 0.26⟩	**14**
dissonance	Criterion 1 - Criterion 8: ⟨0.6, 0⟩ Criterion 1 - Criterion 19: ⟨0.6, 0⟩ Criterion 2 - Criterion 8: ⟨0.6, 0⟩ Criterion 2 - Criterion 19: ⟨0.6, 0⟩ Criterion 4 - Criterion 8: ⟨0.6, 0⟩ Criterion 4 - Criterion 19: ⟨0.6, 0⟩ Criterion 6 - Criterion 8: ⟨0.6, 0⟩ Criterion 6 - Criterion 19: ⟨0.6, 0⟩ Criterion 7 - Criterion 8: ⟨0.6, 0⟩ Criterion 7 - Criterion 19: ⟨0.6, 0⟩ Criterion 8 - Criterion 9: ⟨0.6, 0⟩ Criterion 8 - Criterion 10: ⟨0.6, 0⟩ Criterion 8 - Criterion 11: ⟨0.6, 0⟩ Criterion 8 - Criterion 12: ⟨0.6, 0⟩ Criterion 8 - Criterion 13: ⟨0.6, 0⟩ Criterion 8 - Criterion 14: ⟨0.6, 0⟩ Criterion 8 - Criterion 16: ⟨0.6, 0⟩ Criterion 8 - Criterion 17: ⟨0.6, 0⟩ Criterion 8 - Criterion 19: ⟨0.6, 0⟩ Criterion 8 - Criterion 20: ⟨0.6, 0⟩ Criterion 9 - Criterion 19: ⟨0.6, 0⟩ Criterion 10 - Criterion 19: ⟨0.6, 0⟩ Criterion 11 - Criterion 19: ⟨0.6, 0⟩ Criterion 12 - Criterion 19: ⟨0.6, 0⟩ Criterion 13 - Criterion 19: ⟨0.6, 0⟩ Criterion 14 - Criterion 19: ⟨0.6, 0⟩ Criterion 16 - Criterion 19: ⟨0.6, 0⟩ Criterion 17 - Criterion 19: ⟨0.6, 0⟩ Criterion 19 - Criterion 20: ⟨0.6, 0⟩ Criterion 5 - Criterion 24: ⟨0.6, 0.23⟩ Criterion 1 - Criterion 20: ⟨0.66, 0.34⟩ Criterion 2 - Criterion 20: ⟨0.66, 0.34⟩ Criterion 4 - Criterion 20: ⟨0.66, 0.34⟩ Criterion 6 - Criterion 20: ⟨0.66, 0.34⟩ Criterion 7 - Criterion 20: ⟨0.66, 0.34⟩ Criterion 9 - Criterion 20: ⟨0.66, 0.34⟩ Criterion 10 - Criterion 20: ⟨0.66, 0.34⟩ Criterion 11 - Criterion 20: ⟨0.66, 0.34⟩ Criterion 12 - Criterion 20: ⟨0.66, 0.34⟩ Criterion 13 - Criterion 20: ⟨0.66, 0.34⟩ Criterion 14 - Criterion 20: ⟨0.66, 0.34⟩ Criterion 16 - Criterion 20: ⟨0.66, 0.34⟩ Criterion 17 - Criterion 20: ⟨0.66, 0.34⟩ Criterion 3 - Criterion 5: ⟨0.6, 0.34⟩ Criterion 5 - Criterion 25: ⟨0.6, 0.34⟩ Criterion 18 - Criterion 25: ⟨0.6, 0.34⟩ Criterion 22 - Criterion 25: ⟨0.6, 0.34⟩ Criterion 23 - Criterion 25: ⟨0.6, 0.34⟩ Criterion 3 - Criterion 21: ⟨0.57, 0.34⟩ Criterion 3 - Criterion 18: ⟨0.6, 0.4⟩ Criterion 3 - Criterion 22: ⟨0.6, 0.4⟩ Criterion 3 - Criterion 23: ⟨0.6, 0.4⟩	**52**

Type of correlations	Pairs	Nr. of pairs of criteria
strong dissonance	Criterion 21 - Criterion 25: ⟨0.51, 0.34⟩ Criterion 21 - Criterion 24: ⟨0.46, 0.34⟩ Criterion 15 - Criterion 25: ⟨0.43, 0.34⟩ Criterion 18 - Criterion 24: ⟨0.49, 0.4⟩ Criterion 22 - Criterion 24: ⟨0.49, 0.4⟩ Criterion 23 - Criterion 24: ⟨0.49, 0.4⟩ Criterion 5 - Criterion 8: ⟨0.34, 0.26⟩ Criterion 5 - Criterion 19: ⟨0.34, 0.26⟩ Criterion 3 - Criterion 15: ⟨0.43, 0.4⟩ Criterion 15 - Criterion 24: ⟨0.31, 0.4⟩ Criterion 1 - Criterion 24: ⟨0.4, 0.49⟩ Criterion 2 - Criterion 24: ⟨0.4, 0.49⟩ Criterion 4 - Criterion 24: ⟨0.4, 0.49⟩ Criterion 6 - Criterion 24: ⟨0.4, 0.49⟩ Criterion 7 - Criterion 24: ⟨0.4, 0.49⟩ Criterion 9 - Criterion 24: ⟨0.4, 0.49⟩ Criterion 10 - Criterion 24: ⟨0.4, 0.49⟩ Criterion 11 - Criterion 24: ⟨0.4, 0.49⟩ Criterion 12 - Criterion 24: ⟨0.4, 0.49⟩ Criterion 13 - Criterion 24: ⟨0.4, 0.49⟩ Criterion 14 - Criterion 24: ⟨0.4, 0.49⟩ Criterion 16 - Criterion 24: ⟨0.4, 0.49⟩ Criterion 17 - Criterion 24: ⟨0.4, 0.49⟩ Criterion 20 - Criterion 21: ⟨0.4, 0.51⟩ Criterion 15 - Criterion 20: ⟨0.34, 0.49⟩ Criterion 8 - Criterion 15: ⟨0, 0.43⟩ Criterion 15 - Criterion 19: ⟨0, 0.43⟩ Criterion 8 - Criterion 24: ⟨0, 0.49⟩ Criterion 19 - Criterion 24: ⟨0, 0.49⟩ Criterion 8 - Criterion 21: ⟨0, 0.51⟩ Criterion 19 - Criterion 21: ⟨0, 0.51⟩	**31**
dissonance	Criterion 1 - Criterion 3: ⟨0.4, 0.6⟩ Criterion 2 - Criterion 3: ⟨0.4, 0.6⟩ Criterion 3 - Criterion 4: ⟨0.4, 0.6⟩ Criterion 3 - Criterion 6: ⟨0.4, 0.6⟩ Criterion 3 - Criterion 7: ⟨0.4, 0.6⟩ Criterion 3 - Criterion 9: ⟨0.4, 0.6⟩ Criterion 3 - Criterion 10: ⟨0.4, 0.6⟩ Criterion 3 - Criterion 11: ⟨0.4, 0.6⟩ Criterion 3 - Criterion 12: ⟨0.4, 0.6⟩ Criterion 3 - Criterion 13: ⟨0.4, 0.6⟩ Criterion 3 - Criterion 14: ⟨0.4, 0.6⟩ Criterion 3 - Criterion 16: ⟨0.4, 0.6⟩ Criterion 3 - Criterion 17: ⟨0.4, 0.6⟩ Criterion 1 - Criterion 25: ⟨0.34, 0.6⟩ Criterion 2 - Criterion 25: ⟨0.34, 0.6⟩ Criterion 4 - Criterion 25: ⟨0.34, 0.6⟩ Criterion 5 - Criterion 20: ⟨0.34, 0.6⟩ Criterion 6 - Criterion 25: ⟨0.34, 0.6⟩ Criterion 7 - Criterion 25: ⟨0.34, 0.6⟩ Criterion 9 - Criterion 25: ⟨0.34, 0.6⟩ Criterion 10 - Criterion 25: ⟨0.34, 0.6⟩ Criterion 11 - Criterion 25: ⟨0.34, 0.6⟩ Criterion 12 - Criterion 25: ⟨0.34, 0.6⟩ Criterion 13 - Criterion 25: ⟨0.34, 0.6⟩ Criterion 14 - Criterion 25: ⟨0.34, 0.6⟩ Criterion 16 - Criterion 25: ⟨0.34, 0.6⟩ Criterion 17 - Criterion 25: ⟨0.34, 0.6⟩ Criterion 18 - Criterion 20: ⟨0.34, 0.66⟩ Criterion 20 - Criterion 22: ⟨0.34, 0.66⟩ Criterion 20 - Criterion 23: ⟨0.34, 0.66⟩ Criterion 3 - Criterion 8: ⟨0, 0.6⟩ Criterion 3 - Criterion 19: ⟨0, 0.6⟩ Criterion 8 - Criterion 18: ⟨0, 0.6⟩ Criterion 8 - Criterion 22: ⟨0, 0.6⟩ Criterion 8 - Criterion 23: ⟨0, 0.6⟩ Criterion 8 - Criterion 25: ⟨0, 0.6⟩ Criterion 18 - Criterion 19: ⟨0, 0.6⟩ Criterion 19 - Criterion 22: ⟨0, 0.6⟩ Criterion 19 - Criterion 23: ⟨0, 0.6⟩ Criterion 19 - Criterion 25: ⟨0, 0.6⟩	**40**

Type of correlations	Pairs	Nr. of pairs of criteria
weak dissonance	Criterion 5 - Criterion 18: ⟨0.26, 0.69⟩ Criterion 5 - Criterion 22: ⟨0.26, 0.69⟩ Criterion 5 - Criterion 23: ⟨0.26, 0.69⟩ Criterion 5 - Criterion 21: ⟨0.17, 0.69⟩ Criterion 5 - Criterion 15: ⟨0.09, 0.69⟩	**5**
weak negative consonance	Criterion 20 - Criterion 24: ⟨0.06, 0.83⟩ Criterion 1 - Criterion 15: ⟨0, 0,83⟩ Criterion 2 - Criterion 15: ⟨0, 0,83⟩ Criterion 4 - Criterion 15: ⟨0, 0.83⟩ Criterion 6 - Criterion 15: ⟨0, 0.83⟩ Criterion 7 - Criterion 15: ⟨0, 0.83⟩ Criterion 9 - Criterion 15: ⟨0, 0.83⟩ Criterion 10 - Criterion 15: ⟨0, 0.83⟩ Criterion 11 - Criterion 15: ⟨0, 0.83⟩ Criterion 12 - Criterion 15: ⟨0, 0.83⟩ Criterion 13 - Criterion 15: ⟨0, 0.83⟩ Criterion 14 - Criterion 15: ⟨0, 0.83⟩ Criterion 15 - Criterion 16: ⟨0, 0.83⟩ Criterion 15 - Criterion 17: ⟨0, 0.83⟩	**14**
negative consonance	Criterion 1 - Criterion 21: ⟨0.06, 0.86⟩ Criterion 2 - Criterion 21: ⟨0.06, 0.86⟩ Criterion 4 - Criterion 21: ⟨0.06, 0.86⟩ Criterion 6 - Criterion 21: ⟨0.06, 0.86⟩ Criterion 7 - Criterion 21: ⟨0.06, 0.86⟩ Criterion 9 - Criterion 21: ⟨0.06, 0.86⟩ Criterion 10 - Criterion 21: ⟨0.06, 0.86⟩ Criterion 11 - Criterion 21: ⟨0.06, 0.86⟩ Criterion 12 - Criterion 21: ⟨0.06, 0.86⟩ Criterion 13 - Criterion 21: ⟨0.06, 0.86⟩ Criterion 14 - Criterion 21: ⟨0.06, 0.86⟩ Criterion 16 - Criterion 21: ⟨0.06, 0.86⟩ Criterion 17 - Criterion 21: ⟨0.06, 0.86⟩ Criterion 3 - Criterion 20: ⟨0.06, 0.94⟩ Criterion 20 - Criterion 25: ⟨0, 0.94⟩	**15**
strong negative consonance	Criterion 1 - Criterion 18: ⟨0, 1⟩ Criterion 1 - Criterion 22: ⟨0, 1⟩ Criterion 1 - Criterion 23: ⟨0, 1⟩	**39**

Type of correlations	Pairs	Nr. of pairs of criteria
	Criterion 2 - Criterion 18: ⟨0, 1⟩ Criterion 2 - Criterion 22: ⟨0, 1⟩ Criterion 2 - Criterion 23: ⟨0, 1⟩ Criterion 4 - Criterion 18: ⟨0, 1⟩ Criterion 4 - Criterion 22: ⟨0, 1⟩ Criterion 4 - Criterion 23: ⟨0, 1⟩ Criterion 6 - Criterion 18: ⟨0, 1⟩ Criterion 6 - Criterion 22: ⟨0, 1⟩ Criterion 6 - Criterion 23: ⟨0, 1⟩ Criterion 7 - Criterion 18: ⟨0, 1⟩ Criterion 7 - Criterion 22: ⟨0, 1⟩ Criterion 7 - Criterion 23: ⟨0, 1⟩ Criterion 9 - Criterion 18: ⟨0, 1⟩ Criterion 9 - Criterion 22: ⟨0, 1⟩ Criterion 9 - Criterion 23: ⟨0, 1⟩ Criterion 10 - Criterion 18: ⟨0, 1⟩ Criterion 10 - Criterion 22: ⟨0, 1⟩ Criterion 10 - Criterion 23: ⟨0, 1⟩ Criterion 11 - Criterion 18: ⟨0, 1⟩ Criterion 11 - Criterion 22: ⟨0, 1⟩ Criterion 11 - Criterion 23: ⟨0, 1⟩ Criterion 12 - Criterion 18: ⟨0, 1⟩ Criterion 12 - Criterion 22: ⟨0, 1⟩ Criterion 12 - Criterion 23: ⟨0, 1⟩ Criterion 13 - Criterion 18: ⟨0, 1⟩ Criterion 13 - Criterion 22: ⟨0, 1⟩ Criterion 13 - Criterion 23: ⟨0, 1⟩ Criterion 14 - Criterion 18: ⟨0, 1⟩ Criterion 14 - Criterion 22: ⟨0, 1⟩ Criterion 14 - Criterion 23: ⟨0, 1⟩ Criterion 16 - Criterion 18: ⟨0, 1⟩ Criterion 16 - Criterion 22: ⟨0, 1⟩ Criterion 16 - Criterion 23: ⟨0, 1⟩ Criterion 17 - Criterion 18: ⟨0, 1⟩ Criterion 17 - Criterion 22: ⟨0, 1⟩ Criterion 17 - Criterion 23: ⟨0, 1⟩	

Overall, the pairs of criteria in this dataset show more consonances than those from part 1 and there are far fewer pairs in strong dissonance as part of the whole. When we compare this analysis with unweighted ICA, we get the following results:

Type of correlations	ICA – no weights	ICA with object weights
strong positive consonance	**81**	**81**
positive consonance	**0**	**5**
weak positive consonance	**18**	**4**
weak dissonance	**0**	**14**
dissonance	**40**	**52**
strong dissonance	**53**	**31**
dissonance	**51**	**40**
weak dissonance	**0**	**5**
weak negative consonance	**18**	**14**
negative consonance	**0**	**15**
strong negative consonance	**39**	**39**

The IFPs evaluating the criteria pairs have the form from Figure 3 when visualized on the IF triangle:

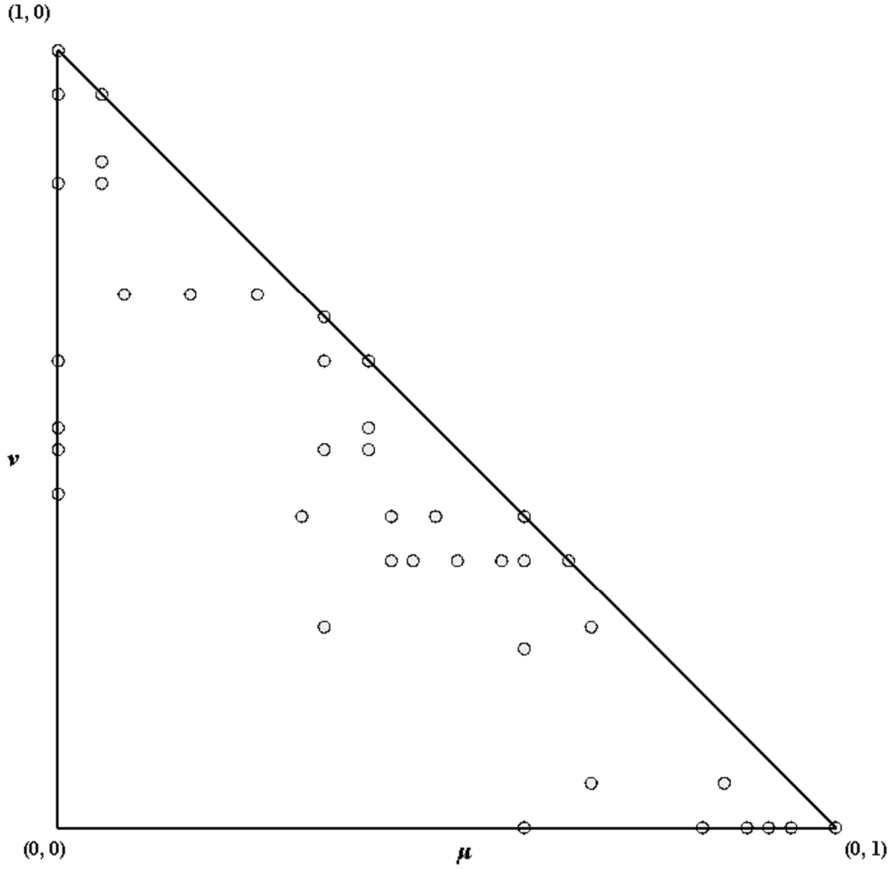

Figure 3 Intuitionistic Fuzzy Triangle – results for Constant Coke (1,9)

3 Conclusion

A great number of data generated during fluid catalytic cracking of two feeds: straight run vacuum gas oil derived from Urals crude oil, and the same feed activated with 2% FCC slurry oil on two commercial catalysts: fresh steam deactivated Futura 70+, and an equilibrium catalyst sampled from the LUKOIL Neftohim Burgas FCC unit was evaluated by InterCriteria Analysis with the aim to compare the criteria using the provided object weights. The results have shown that the case of evaluating the yields and product properties interpolated at constant conversion of 65% there are more criteria pairs (yields and product properties) in dissonance than in the case when the evaluation is performed for the yields and product properties interpolated at constant coke yield of 1.9%. The latter case (constant coke) shows more pairs in positive and negative consonance. Considering that the commercial FCC unit is heat balanced that makes it operate at constant coke yield the results of this study concerning the case with constant coke could be deemed meaningful for the industrial application of the FCC process when different feeds are cracked on different catalysts.

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