stream) of 1000 kg/h with the composition listed in table 5 is assumed (typical fuel MTBE, compare with table 3).

Table 5: Composition of the assumed MTBE entry stream (I) and of the distillate (II*) and of the bottom product (IV*) for column K1* for example 2a

	Starting MTBE (I)	K1* distillate (II*)	K1* bottom prod. (IV*)
Mass flow rate [kg/h]	1000.0	4.2	995.8
Parts by mass [kg/kg]			
dimethyl ether			
isobutene			
n-butane	0.000150	0.035549	
1- / 2-butenes	0.001030	0.244102	
C5 hydrocarbons	0.002000	0.462191	0.000050
MTBE	0.979165	0.150000	0.982679
2-methoxybutane	0.002500	0.000064	0.002510
methanol	0.009500	0.108011	0.009083
tert-butanol	0.003000		0.003013
water	0.000005	0.000005	0.000005
diisobutene	0.002500		0.002511
acetone	0.000150	0.000078	0.000150

Column K1* has 40 theoretical plates and is operated at a pressure of 0.35 $MPa_{(abs)}$. Feed (I) is applied above plate 15, counted from the top. The reflux was set to 671 kg/h, such that the MTBE content in the distillate (II*) is firstly low (MTBE loss), and the bottom product (IV*) is secondly very substantially free of low boilers (C4 and C5 hydrocarbons). The distillate of this column K1* has a residual content of 15% by mass of MTBE and the bottom product a residual content of C4 and C5 hydrocarbons of 50 ppm. The acetone present in the starting MTBE (150 ppm) is not removed in this operating mode of the column; the concentration in the bottom product (IV*) is unchanged at 150 ppm.

This example showed that, in a customary operating mode of the low boiler column described in the literature, acetone is not removed from the starting MTBE (I).

Example 2b: (noninventive)

In example 2b, the distillate mass flow rate of column K1* is adjusted such that, with the same reflux flow rate, 80% by mass of the acetone present in feed stream (I) is separated into the distillate. Mass flow rate and composition of feed stream (I), and pressure, number of plates and application level for column K1* remain unchanged from example 2a.

The mass flow rates and the corresponding composition of distillate (II*) and bottom product (IV*) are shown in table 6.

Table 6: Composition of the distillate (II*) and of the bottom product (IV*) for column K1* for example 2b

	K1* distillate (II*)	K1* bottom prod. (IV*)
Mass flow rate [kg/h]	232.9	767.1
Parts by mass [kg/kg]		
dimethyl ether		
isobutene		
n-butane	0.000644	
1- / 2-butenes	0.004423	
C5 hydrocarbons	0.008570	0.000006
MTBE	0.942549	0.990281
2-methoxybutane	0.001066	0.002935
methanol	0.040794	
tert-butanol	0.001417	0.003480
water	0.000021	
diisobutene		0.003259
acetone	0.000515	0.000039

As is evident from table 6, the distillate mass flow rate has to be increased from 4.2 kg/h in Example 2a to 233 kg/h in order to remove 80% by mass of the acetone present in feed stream (I) from the bottom product (IV*). The MTBE content in the distillate is approx. 94% by mass. Thus, the MTBE loss is considerable (22% by mass). The content of C4 and C5 hydrocarbons

in the distillate totals approx. 1.4% by mass. Thus, this stream is unsuitable as a fuel additive without being worked up again.

Example 2c: (noninventive)

In example 2c, the reflux flow rate of column K1* is increased to 947 kg/h and the distillate mass flow rate of column K1* is adjusted such that 80% by mass of the acetone present in feed stream (I) is again separated into the distillate. Mass flow rate and composition of feed stream (I) and pressure, number of plates and application level for column K1* remain unchanged from example 2a.

The mass flow rates and the corresponding composition of distillate (II*) and bottom product (IV*) are shown in table 7.

Table 7: Composition of the distillate (II*) and of the bottom product (IV*) for column K1* for example 2c

	K1* distillate (II*)	K1* bottom prod. (IV*)
Mass flow rate [kg/h]	130.2	869.8
Parts by mass [kg/kg]		
dimethyl ether		
isobutene		
n-butane	0.001152	
1- / 2-butenes	0.007909	
C5 hydrocarbons	0.015331	0.000004
MTBE	0.900536	0.990939
2-methoxybutane	0.000530	0.002795
methanol	0.072946	
tert-butanol	0.000638	0.003354
water	0.000038	
diisobutene		0.002874
acetone	0.000921	0.000034

In spite of an increase in the reflux, approx. 11% by mass of the MTBE present in the feed stream is still discharged via the distillate (MTBE loss). The content of C4 and C5 hydrocarbons in distillate (I*) has to approx. 2.4% by mass compared to example 2b. Thus, this stream is unsuitable as a fuel additive without being worked up again.

Example 3a: (inventive)

Example 3a corresponds to the process shown in Figure 1. Column K1, in contrast to column K1* in examples 2a and 2b, is operated with a side draw (III). Mass flow rate and composition of feed stream (I) remain unchanged from example 2a.

Column K1 has 52 theoretical plates and is operated at a pressure of 0.35 $MPa_{(abs)}$. Feed (I) is applied above plate 27, counted from the top. Side draw (II) is withdrawn in liquid form from plate 12 and is adjusted to 70 kg/h. The reflux rate was selected as in example 2a (670 kg/h).

Table 8: Composition of distillate (II), of side draw (III) and of bottom product (IV) for column K1 for example 3a

	K1 distillate (II)	K1 bottom prod. (IV)	K1 side draw (III)
Mass flow rate [kg/h]	4.0	926.0	70.0
Parts by mass [kg/kg]			
dimethyl ether			
isobutene			
n-butane	0.036276		0.000054
1- / 2-butenes	0.245209		0.000593
C5 hydrocarbons	0.460260	0.000023	0.001758
MTBE	0.150000	0.991320	0.866124
2-methoxybutane	0.000018	0.002670	0.000391
methanol	0.107805		0.129506
tert-butanol		0.003222	0.000235
water	0.000009		0.000071
diisobutene		0.002700	
acetone	0.000424	0.000064	0.001267

The distillate (II) of this column K1 has, as in example 2a, a residual content of 15% by mass of MTBE, while the bottom product (IV) comprises only 23 ppm of C5 hydrocarbons (see table 8). The acetone present in the starting MTBE (150 ppm) in this operating mode is discharged via the side stream (II) to an extent of approx. 60% by mass; the bottom stream (IV) comprises only approx. 40% by mass of the original amount. As can be inferred from table 8, the distillate mass flow rate (I) remains virtually unchanged from example 2a, and hence also the MTBE loss via this stream. In the side stream, only approx. 6% by mass of the amount of MTBE present in the feed stream is discharged. In contrast to the distillate streams in examples 2b and 2c, the content of C4 and C5 hydrocarbons in the side stream, however, is low (approx. 2400 ppm), and so this stream (II) can be marketed as a fuel additive, optionally also after mixing with a stream from an MTBE synthesis.

Example 3b: (inventive)

In example 3b, the reflux flow rate of column K1, as in example 2c, is increased to 947 kg/h and the distillate mass flow rate of column K1* is adjusted such that the distillate (II) again comprises a residual content of 15% by mass of MTBE. Composition of the feed stream (I) and pressure, number of plates and application level for feed stream and withdrawal level for the side draw for column K1 remain unchanged from example 3a.

The mass flow rates and the corresponding composition of distillate (II), side draw (III) and bottom product (IV) are shown in table 9.

Table 9: Composition of distillate (II), of side draw (III) and of bottom product (IV) for column K1 for example 3b

	K1 distillate (II)	K1 bottom prod. (IV)	K1 side draw (III)
Mass flow rate [kg/h]	4.1	925.9	70.0
Parts by mass [kg/kg]			
dimethyl ether			
isobutene			
n-butane	0.035756		0.000038
1- / 2-butenes	0.242768		0.000426
C5 hydrocarbons	0.462660	0.000004	0.001295

The reactor output from reactor RS1-3 is supplied to column KS1-1. The column has 70 theoretical plates and the feed is above plate 50, counted from the top. The column is operated at a reflux ratio of 0.9 and at a pressure of 0.65 $MPa_{(abs)}$. The bottom product (I) (starting MTBE) is technical MTBE; see table 10. In column KS1-1, acetone passes completely into the bottoms. The distillate (XXII) consists predominantly of C4 hydrocarbons and of methanol, DME formed in the MTBE synthesis and water. In further workup steps known from the literature, for example extraction, the distillate (XXII) can be freed of oxygenates and processed further to give further products of value.

The MTBE stream (I) comprises a total of approx. 1250 ppm of C4 and C5 hydrocarbons, and approx. 120 ppm of acetone. According to the invention, the C4 and C5 hydrocarbons and the acetone are removed from this stream in column K1. Column K1 has, as in examples 3a and 3b, 52 theoretical plates and is operated at a reflux rate of 1341 kg/h and at a pressure of 0.35 $MPa_{(abs)}$. Feed (I) is applied above plate 27, counted from the top. The side draw (II) is withdrawn in liquid form from plate 12 and set to 70 kg/h.

Table 11 shows the of distillate (II), of side draw (III) and of bottom product (IV) of column K1.

Table 11: Composition of distillate (II), of side draw (III) and of bottom product (IV) of column K1 for example 4

	K1 distillate (II)	K1 side draw (III)	K1 bottom prod. (IV)
Mass flow rate [kg/h]	1.8	70.0	1045.2
Parts by mass [kg/kg]			
dimethyl ether			
isobutane			
isobutene			
n-butane	0.000004		
butadiene			
1- / 2-butenes	0.264378	0.000133	
C5 hydrocarbons	0.476646	0.000424	0.00001
MTBE	0.150000	0.848364	0.982642

The feed (I) is applied above plate 15, counted from the top. In order to achieve, analogously to example 2a, a concentration of 50 ppm of C4 and C5 hydrocarbons in the bottom product (IV*), the column is operated at a reflux rate of 826 kg/h. Table 17 shows the composition of the distillate stream (II*) and of the bottom stream (IV*) of column K1*.

Table 17: Composition of the distillate (II*) and of the bottom product (IV*) for column K1* for example 5

	K1* distillate (II*)	K1* bottom prod. (IV*)
Mass flow rate [kg/h]	1.9	1127.4
Parts by mass [kg/kg]		
dimethyl ether		
isobutane		
isobutene		
n-butane	0.000004	
butadiene		
1- / 2-butenes	0.273941	
C5 hydrocarbons	0.467714	0.000050
MTBE	0.150000	0.971288
2-methoxybutane	0.000086	0.003424
methanol	0.107314	0.009338
tert-butanol		0.012523
water	0.000006	0.000004
diisobutene		0.001778
acetone	0.000936	0.001595

Acetone in this operating mode, as already shown in example 2a, is not removed and discharged from the process.

The MTBE stream (IV*) is supplied to column K2, in which diisobutene and 2-methoxybutane are removed via the bottom (V). The number of plates and column pressure remain unchanged from example 4. The reflux ratio is 2.9. Compositions and mass flow rates of top and bottom product of column K2 are shown in table 18. The acetone in this column again passes completely into the distillate.

Claims

1. Process for purifying technical MTBE (methyl tert-butyl ether), which comprises the following steps:
   a) providing technical MTBE (I) comprising at least MTBE, methanol, C4 hydrocarbons, C5 hydrocarbons and acetone; and
   b) distillatively separating the technical MTBE (I) into a top product (II) comprising C4 and C5 hydrocarbons, a side stream (III) comprising acetone, methanol and MTBE, and a bottom product (IV) comprising MTBE.

2. Process according to Claim 1, characterized in that the distillative separation in process step b) is performed in such a way that the bottom product (IV) comprises less than 50% by mass of the acetone present in the technical MTBE (I).

3. Process according to Claim 1 or 2, characterized in that the distillative separation in process step b) is performed in a distillation column and the side stream (III) is withdrawn in liquid form.

4. Process according to at least one of Claims 1 to 3, characterized in that the MTBE-comprising bottom product (IV) from process step b) is separated in a process step c) in a further distillation into an MTBE-containing top product (VI) and a bottom product (V) comprising higher-boiling components than MTBE.

5. Process according to Claim 4, characterized in that the distillative separation in process step c) is performed in such a way that the MTBE-containing top product (VI) has a concentration of less than 2500 ppm by mass of 2-methoxybutane.

6. Process according to any of Claims 1 to 5, characterized in that the MTBE-comprising bottom product (IV) or the MTBE-containing top product (VI) comprises less than 50 ppm by mass of acetone.

7. Process according to any of Claims 1 to 6, characterized in that the MTBE-comprising bottom product (IV) or the MTBE-containing top product (VI) is catalytically cracked in a process step d) to obtain a cracking product (VII) comprising at least MTBE, isobutene and methanol.