Title: PROCESS FOR IMPROVING ADIPONITRILE QUALITY

Abstract: A process and apparatus for reacting deleterious impurities contained in adiponitrile (ADN) comprises feeding ADN and an ozone containing gas into a co-current plug flow reactor containing static mixer elements, to oxidize at least a portion of the impurities, thereby producing a reactor discharge, which is processed to produce an ozone-treated ADN product.
1. A process for reacting impurities present in adiponitrile (ADN) comprising: introducing ADN feed and an ozone-containing gas to a co-current plug flow static mixer reactor (PFSMR) and contacting the ADN feed with said ozone-containing gas in said PFSMR to oxidize at least a portion of said impurities, to produce a reactor discharge.

2. A process of claim 1, wherein the reactor discharge includes a gas and an ozone-treated ADN liquid, which includes unreacted impurities and less deleterious impurities.

3. A process of claim 2, wherein the reactor discharge is conducted to an apparatus which separates the gas from the ozone-treated ADN liquid to produce an off-gas and a degassed liquid, which is an ozone-treated ADN product.

4. A process of claim 3, wherein the off-gas is discharged to the atmosphere or to a catalytic abatement unit.

5. A process of claim 1, wherein the ozone-containing gas comprises ozone and a carrier gas, and wherein said carrier gas is any gas that is substantially inert to the ADN feed at operating temperature of the process.

6. A process of claim 5, wherein the carrier gas is air, air diluted with nitrogen, oxygen-enriched air, nitrogen, carbon dioxide, helium, argon, or a mixture thereof.

7. A process of claim 5, wherein the ozone-containing gas comprises about 0.1 to about 3 % wt. of ozone.
8. A process of claim 5, wherein the ozone-containing gas comprises about 3.0 % wt of ozone.

9. A process of claim 1, wherein the impurities include at least one of 2-cyanocyclopentylideneimine (CPI), phosphorous (III) compounds (P(III)), or tert-butyl catechol (TBC).

10. A process of claim 9, wherein the ADN feed comprises about 0.5 to about 10 ppm P(III), about 10 to about 200 ppm CPI, about 5 to about 100 ppm TBC, or a combination thereof.

11. A process of claim 9, wherein the ADN feed comprises about 2 to about 10 ppm P(III), about 10 to about 50 ppm CPI, about 10 to about 50 ppm TBC, or a combination thereof.

12. A process of claim 3, wherein the ozone-treated ADN product comprises less than 1 ppm P(III), less than 5 ppm CPI, and less than 5 ppm TBC.

13. A process of claim 1, wherein the amount of ozone supplied to the process is sufficient to react at least about 90% of the TBC present in the ADN feed.

14. A process of claim 1, wherein about 0.1 to about 4 mmoles of ozone per liter of the ADN feed is supplied to the process.

15. A process of Claim 1 wherein the ADN feed is produced by the hydrocyanation of butadiene using a homogeneous nickel(O) catalyst with phosphorous containing ligands.
16. A process of Claim 1 where the ozone is produced by passing air through an ozone generator that produces a gaseous stream comprising about 3 wt % ozone.

17. A process of claim 1, wherein the ozone consumption in the PFSMR is in excess of 99% of the ozone fed to the PFSMR.

18. A process of claim 1, wherein the mass transfer parameter (M) is about 0.1 second \(^{-1}\) or greater.

19. A process of claim 1, wherein the mass transfer parameter (kja) is about 0.5 second \(^{-1}\) or greater.

20. A process of claim 1, wherein the residence time of the ADN feed and the ozone-containing gas in the PFSMR is about 2 to about 8 seconds.

21. A process of claim 1, wherein the residence time of the ADN feed and the ozone-containing gas in the PFSMR is about 2 to about 4 seconds.

22. A process of claim 1, wherein the residence time of the ADN feed and the ozone-containing gas in the PFSMR is about 3 seconds.

23. A process of claim 3, wherein the ozone-treated ADN product is hydrogenated to ACN and HMD.

24. A process of claim 1, wherein the pressure drop across the PFSMR is at least about 1 atmosphere (101.3 kPa).
25. A process for reacting impurities present in adiponitrile (ADN) including 2-
cyanocyclopentyldenemimine (CPI), phosphorous (III) compounds (P(III)), or
tertbutylcatechol (TBC) comprising: introducing ADN feed and an ozone-containing
gas to a co-current plug flow static mixer reactor (PFSMR) and contacting the ADN
feed with said ozone-containing gas in said PFSMR to oxidize at least a portion of
said impurities and less deleterious impurities.

26. A process of claim 25 wherein the reactor discharge includes a gas and an ozone-
treated ADN liquid, which includes unreacted impurities and less deleterious
impurities.

27. A process of claim 26 wherein the reactor discharge is conducted to an apparatus
which separates the gas from the ozone-treated ADN liquid to produce an off-gas
and a degassed liquid, which is an ozone-treated ADN product.

28. A process of claim 27 wherein the off-gas is discharged to the atmosphere or to a
catalytic abatement unit.

29. A process of claim 25 wherein the ozone-containing gas comprises ozone and a
carrier gas, and wherein said carrier gas is any gas that is substantially inert to the
ADN feed at operating temperature of the process.

30. A process of claim 29 wherein the carrier gas is air, air diluted with nitrogen,
oxygen-enriched air, nitrogen, carbon dioxide, helium, argon, or a mixture thereof.

31. A process of claim 29 wherein the ozone-containing gas comprises about 0.1 to
about 3% wt of ozone.

32. A process of claim 29 wherein the ozone-containing gas comprises about 3.0 % wt
of ozone.

33. A process of claim 25 wherein the ADN feed comprises about 0.5 to about 10 ppm
P(III), about 10 to about 200 ppm CPI, about 5 to about 100 ppm TBC, or a
combination thereof.
34. A process of claim 25 wherein the ADN feed comprises about 2 to about 10 ppm P(III), about 10 to about 50 ppm CPI, about 10 to about 50 ppm TBC, or a combination thereof.

35. A process of claim 27 wherein the ozone-treated ADN product comprises less than 1 ppm P(III), less than 5 ppm CPI, and less than 5 ppm TBC.

36. A process of claim 25 wherein the amount of ozone supplied to the process is sufficient to react at least about 90% of the TBC present in the ADN feed.

37. A process of claim 25 wherein about 0.1 to about 4 mmoles of ozone per liter of the ADN feed is supplied to the process.

38. A process of claim 25 wherein the ADN feed is produced by the hydrocyanation of butadiene using a homogeneous nickel(O) catalyst with phosphorous containing ligands.

39. A process of claim 25 where the ozone is produced by passing air through an ozone generator that produces a gaseous stream comprising about 3 wt % ozone.

40. A process of claim 25 wherein the ozone consumption in the PFSMR is in excess of 99% of the ozone fed to the PFSMR.

41. A process of claim 25 wherein the mass transfer parameter \((k_La)\) is about 0.1 second\(^{-1}\) or greater.

42. A process of claim 25 wherein the mass transfer parameter \((k_La)\) is about 0.5 second\(^{-1}\) or greater.

43. A process of claim 25 wherein the residence time of the ADN feed and the ozone-containing gas in the PFSMR is about 2 to about 8 seconds.

44. A process of claim 25 wherein the residence time of the ADN feed and the ozone-containing gas in the PFSMR is about 3 seconds.

45. A process of claim 25 wherein the residence time of the ADN feed and the ozone-containing gas as in the PFSMR is about 3 seconds.
46. A process of claim 27 wherein the ozone-treated ADN product is hydrogenated to
ACN and HMD.

47. A process of claim 25 wherein the pressure drop across the PFSMR is at least
about 1 atmosphere (101.3 kPa).