



## ACETYLATION OF AMINES : ENVIRONMENTALLY BENIGN METHOD

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### Abstract

An efficient catalytic procedure for acetylation of amines into their corresponding acetylated products in good yields using acetyl chloride in the presence of fly ash catalyst has been described. The catalysts were found to be stable and were recycled several times without significant loss of activity under microwave irradiation in solvent-free conditions.

**Keywords:** Acetylation, amines, microwave irradiation.

### Introduction

Selective protection of amines is one of the most desirable transformations since it provides an efficient and inexpensive means of amino groups in a multistep synthetic process<sup>1</sup>. Acetic anhydride is commonly used reagent for acetylation of anilines. This reagent bears certain disadvantages<sup>2</sup>. In addition acetylation of amines has been carried out by using ethyl acetate<sup>3</sup>, ammonium acetate in acetic acid<sup>4</sup>, acetic acid in presence of Fe(III)-montmorillonite catalyst<sup>5</sup> and acetic acid as acetylating agent under microwave irradiation<sup>6</sup>. Few methods of acetylation of amines are known using acetyl chloride of which most common is the use of acetyl chloride in pyridine<sup>7</sup>. Acetyl chloride has also been used in combination with some fairly exotic reagents such as  $ZrOCl_2 \cdot 8H_2O$ <sup>8</sup>, zinc dust<sup>9</sup> and thermally decomposed Ni-Fe-hydroxalite.<sup>10</sup> Several types of substances such as acids, bases, clays, enzymes, ionic liquids and supercritical solvents have been employed to catalyze reactions. This is due to problems associated with prevailing catalysts like hazardous nature, high cost, tedious work up, difficult to handle,



requirement of large quantities of organic solvents during and after the reaction and above all, their detrimental effects on environment<sup>11</sup>. In an attempt to overcome some of the deficiencies of catalysts used in organic synthesis, development of green procedures using heterogeneous catalysts under solvent-free conditions has aroused great interest in recent years<sup>12</sup>.

Fly ash is the solid waste residue produced from coal, oil, and biomass combustion. In the past few decades, more and more research has been devoted to explore the applications of fly ash in heterogeneous catalysis. It is a silico-aluminate material consisting of  $\text{SiO}_2$ ,  $\text{Al}_2\text{O}_3$ , and  $\text{Fe}_2\text{O}_3$  as the major constituents and varying amount of  $\text{CaO}$ ,  $\text{MgO}$ ,  $\text{SO}_3$  - with unburned carbon. Besides these, some minor elements such as Hg, As, Ge, Ga, and traces of heavy metals (Cr, Co, Cu, Pb, Mn, Ni, Zn) & other rare earth metals may also be present in fly ash<sup>13</sup>. The catalytic role of activated fly ash for different reactions such as oxidation<sup>14-15</sup>, chlorination<sup>16</sup> and condensation of short chain olefins<sup>17</sup> is well documented in the literature. Fly ash was also used as solid support in the synthesis of 2-mercaptobenzothiazole derivatives under microwave irradiation<sup>18</sup>. Solvent free alkylation and acetylation of thymol and geraniol using fly ash as solid support is reported<sup>19</sup>. Recently, solid acid catalyst synthesized from fly ash has been used as a catalyst for acylation of salicylic acid under thermal conditions<sup>20</sup>. Herein we attempted microwave assisted acetylations of amines substrates in presence of fly ash.

### **Materials and Methods**

Fly ash was obtained from Khaparkheda power plant, District Nagpur, Maharashtra state, India. The collected fly ash has the following composition:  $\text{SiO}_2$ , 50-54;  $\text{Al}_2\text{O}_3$ , 22-25;  $\text{Fe}_2\text{O}_3$ , 2-5;  $\text{MgO}$ , 0.5-2.5 and others ( $\text{MnO}_2$ ,  $\text{CaO}$ ,  $\text{P}_2\text{O}_5$ ,  $\text{TiO}_2$ ,  $\text{SO}_3^-$ ,  $\text{Na}_2\text{O}$ ,  $\text{K}_2\text{O}$ ), 0.002-2.5% . The irradiation with 300 W in the MW (Model MO9621, 2450 MHz, 900W)



was employed. Fly ash was riddled in a sieve to remove any coarser and foreign particles. The particle size distribution was found to be between 40-60 $\mu$ m. The acetylations were carried out with the substrate to catalyst ratio as 10:1. The catalyst used in the reaction mixture was thermally stabilized by calcining at 600 °C for 6 h without any agitation and was recovered by filtration and regenerated for next cycle.

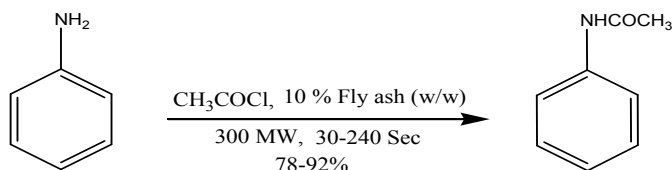
### **Experimental Section**

Acetylation of various amines as shown in Scheme I have been performed by mixing amines substrate (1 mmol) , acetyl choride (1 mmol) & fly ash in a 25 mL vial. The reaction mixture was irradiated in a microwave oven at 300 W for specified time as mentioned in the Table 1. The reactions were monitored on TLC by comparison with authentic samples. Melting points were taken in open capillaries using paraffin baths and are uncorrected. The catalyst was activated at 600 °C in static air prior to the reaction for 6 h. The crude product was subjected to silica gel column chromatography using 5% EtOAc in light petroleum ether as eluent to get corresponding acetylated product in 78-92 % yields (Table 1). The structure of the product was confirmed by <sup>1</sup>H NMR, IR and by comparison with the authentic samples obtained commercially or prepared by reported methods.

#### **Synthesis of N-phenylacetamide (Table No 1, Entry 1)**

To a mixture of substrate (1 mmol) & acetyl chloride (1 mmol) in a 25 mL vial, activated fly ash (amine to catalyst weight ratio 10:1) was added. The reaction mixture was stirred properly with the help of a glass rod (<1min.) and then irradiated in a microwave oven at 300 W. The progress of the reaction was monitored by TLC. The catalyst was removed by filtration and the reaction mass was added in chilled water to get the crude product. The crude product was subjected to silica gel column chromatography using 5% EtOAc in light petroleum ether as eluent to

get N- phenylacetamide (90%).  $^1\text{H}$  NMR (300 MHz,  $\text{CDCl}_3$ )  $\delta$  2.19 (s, 3H), 7.16-7.11 (m, 1H), 7.28(s, 1H), 7.36-7.30 (m, 2H), 7.55-7.52 (m, 2H). IR ( $\text{cm}^{-1}$ ): 3293, 1662, 1598, 1557, 1500, 1431, 1368, 1325, 1262, 1040, 1012, 962, 906, 750.



**Scheme I:** Solvent free acetylation of aromatic amines

**Table 1 :** Microwave irradiated acetylation of aromatic amines under solvent free conditions

Entry	Substrate	Time (Sec.)	Yield (%)	M.P ( °C )	Product
1		60	90	112 <sup>a</sup>	
2		50	88	152 <sup>a</sup>	
3		30	87	112 <sup>a</sup>	
4		30	92	128 <sup>a</sup>	
5		30	89	86 <sup>a</sup>	
6		120	80	250 <sup>a</sup>	
7		180	78	184 <sup>a</sup>	



8		150	79	248 <sup>a</sup>	
9		180	88	216 <sup>a</sup>	
10		240	80	92 <sup>a</sup>	
11		210	86	154 <sup>a</sup>	
12		30	92	178 <sup>a</sup>	
13		40	88	88 <sup>a</sup>	
14		150	84	166 <sup>b</sup>	
15		180	82	208 <sup>b</sup>	
16		120	81	148 <sup>b</sup>	
17		60	85	158 <sup>a</sup>	
18		60	89	132 <sup>a</sup>	

a: See Ref. No. 21, b: See Ref. No. 22



## Results and Discussion

Fly ash catalysed acetylations of amine compounds under microwave irradiation have been carried out and the results in Table 1 suggest generality of this method and the efficiency

of fly ash as a catalyst. The results also indicate the reduction of reaction time as compared to acetylation reaction conducted under thermal conditions<sup>20</sup>. We have examined the recovery and reuse of the activated fly ash in the acetylation of aniline to get N-phenylacetamide and found that the yields of the products in the second and third use of the catalyst were almost

same as that in the first run. In every case, fly ash catalyst was recovered by filtration, washing with acetone and drying in oven at 110 °C for 1 h.

## Conclusion

In conclusion, we have demonstrated an efficient and simple alternative for the acetylation reactions of amines using microwave irradiation under solvent free conditions in presence of fly ash. The process offered a dramatic reduction of reaction time. The attractive features of this process are the mild reaction conditions, high conversions, cleaner reaction profiles, operational simplicity and use of an easily and abundantly available fly ash, an industrial waste pollutant as a recyclable catalyst.

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